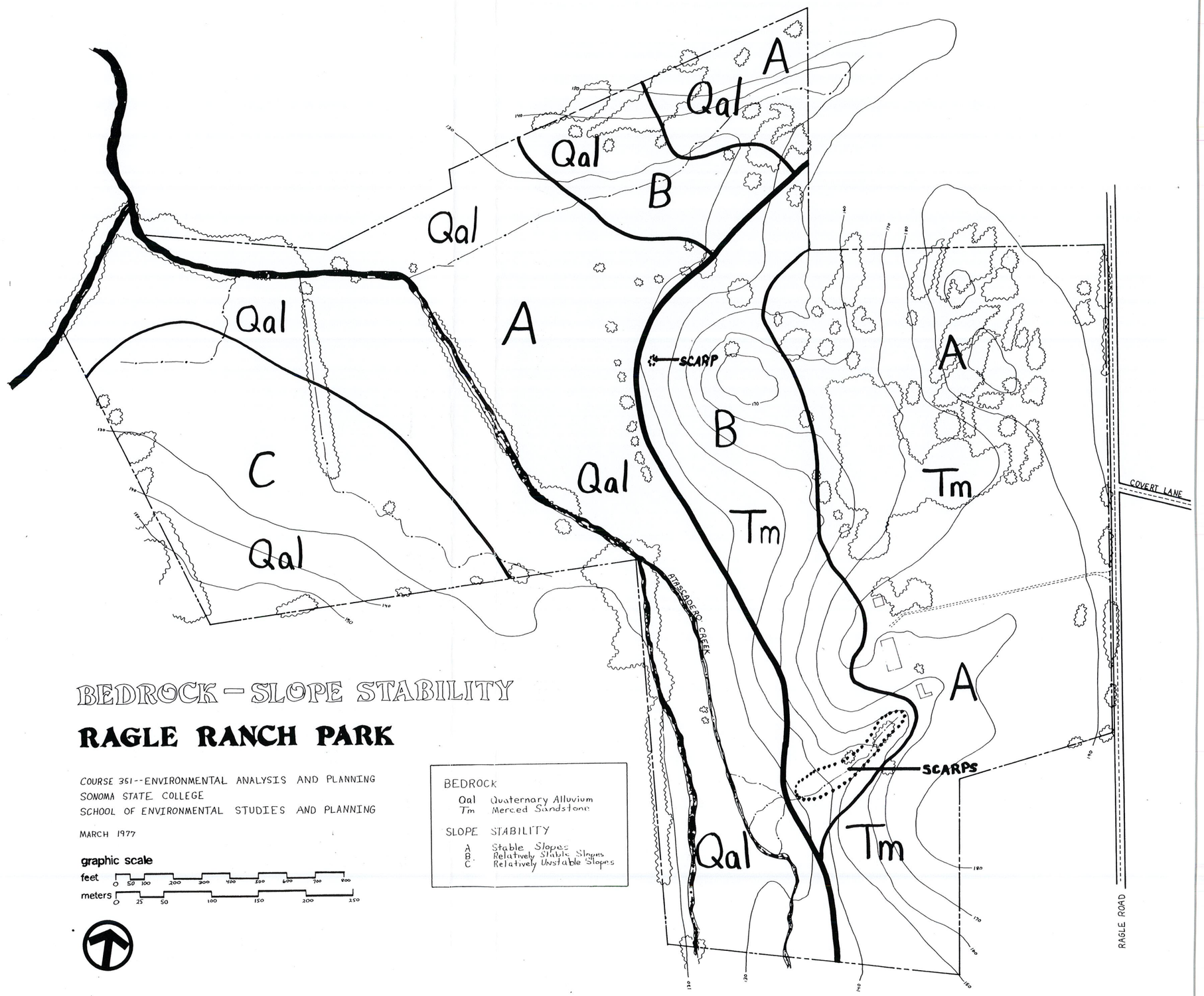


BEDROCK – SLOPE STABILITY

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

graphic scale

feet 0 50 100 200 300 400 500 600 700 800

meters 0 25 50 100 150 200 250

BEDROCK
Qal Quaternary Alluvium
Tm Merced Sandstone

SLOPE STABILITY
A Stable Slopes
B Relatively Stable Slopes
C Relatively Unstable Slopes

RELATIVE HAZARD FROM SEISMIC SHAKING

This occurs mainly in unconsolidated alluvium and terrace deposits. Shaking hazard to structures is related to the thickness of alluvium present. (Note: The farmer reported that two fences in the past 40 years have been buried in the depositional alluvium.) Liquefaction potential varies according to the distribution of clay-free granular materials and groundwater shallower than 50 feet. Groundwater in this zone is generally more shallow than 20 feet. Site geologic studies are recommended.

SOILS--THE PAJARO ASSOCIATION

Somewhat poorly drained, nearly level to gently sloping fine sandy loams to clay loams, this soil group is found on low terraces and flood plains. This soil association is in long, fairly narrow valleys. Most areas are in the southern part of the county between Petaluma and Two Rock, but one area extends from west of Sebastopol to the vicinity of Graton. The soils are formed in alluvium, washed from the hills of soft sedimentary coastal sandstone and mixed with material from fine-grained hard sandstone and shale. The vegetation is grasses, forbs, shrubs and wild berry vines. The annual precipitation is 30 to 35 inches. The annual temperature is about 51° F. The frost-free season is about 270 days per year.

Pajaro soils have a surface layer of grayish-brown fine sandy loam or clay loam. The substratum is mottled gray fine sandy loam.

Most of these soils have been cultivated and are used for dry-farmed or irrigated pasture and hay. Row crops and grapes are grown in places on the better drained areas, and corn is grown in a few places, mainly for silage. Many fine dairies are compatible with these soils. During the rainy season, some areas of these soils are flooded because of the combined effect of heavy rainfall and excess runoff from tributaries to the main drainages. (More detailed information is available for the soil profiles and textures in Appendices B and C.)

SOILS AND AGRICULTURE

Blucher (BhB)

Blucher loam is a fine sandy loam in which the finer textures are

CHARACTERISTICS		SOIL SERIES			
		Blucher (BhB)	Goldridge (GdC)	Goldridge (GdD)	Pajaro (PaA)
Storie Index		Grade 2	Grade 2	Grade 3	Grade 2
Capability Unit		II w-2	III e-1	IV e-1	II w-2
Woodland Group		--	4	4	--
Wildlife Group		2	7	7	2
Depth to Water Table (in feet)		3.5 to 5.0	2.0	2.0	3.0 to 5.0
Available Water	Capacity	0.14 to 0.18	0.13 to 0.15	0.14 to 0.16	0.13 to 0.15
	Availability	6" to 8"	9" to 11"	9" to 11"	8" to 10"
Permeability		0.63 to 2.0 Slow	0.63 to 2.0 Moderately Slow	0.2 to 0.63 Moderately Slow	0.2 to 0.63 Moderately Slow
Ph Factor		5.6 to 8.4 Medium Acid to Moderate Alkaline	4.5 to 6.5 Very Strong Acid to Neutral	4.5 to 5.5 Very Strong Acid to Neutral	5.6 to 8.4 Medium Acid to Moderate Alkaline
Shrink-Swell Potential		Low to Moderate	Low	Moderate	Low
Depth to Bedrock or Hardpan		5.0+	3.5 to 5.0	3.5 to 5.0	5.0+

CHARACTERISTICS	SOIL SERIES			
	Blucher (BhB)	Goldridge (GdC)	Goldridge (GdD)	Pajaro (PaA)
Agricultural Drainage	Slow Permeability	Not Needed	Not Needed	Moderately Slow Permeability
Texture (USDA)	Fine Sandy Loam, Loam, Silt Loam	Fine Sandy Loam	Sandy Clay Loam	Fine Sandy Loam
Slope	2% to 5%	2% to 9%	9% to 15%	0 to 2%
Runoff	Slow to Medium	Slow to Medium	Medium	Very Slow
Fertility	Moderately High to High	Moderately High to Moderately Low	Moderately Low to Moderately High	Moderately High to High
Erosion Hazard	Slight	Slight to Moderate	Moderate	Slight
Agricultural Use Other Than Grazing	Oak Woodland Forest	Douglas Fir-Redwood Forest	Douglas Fir-Redwood Forest	Marshland, Vernal Pools, Rushes
Frost-Free Season	250 to 270 Days	220 to 240 Days	220 to 240 Days	250 to 270 Days
Soils Underlain By	Mixed Sedimentary Alluvium, Stratified Silt and Clay	Coarse-Grained Weakly Consolidated Sandstone	Coarse-Grained Weakly Consolidated Sandstone	Alluvium Material from Sedimentary Sources
Soils Found Other Than Floodplain	Marine Terrace, Uplands, Stream Basin, Alluvial Fan	Uplands and Marine Terrace	Uplands and Marine Terrace	Marine Terrace, Uplands, Stream Basin, Alluvial Fan
Effective Rooting Depth to Water Table	40" to 60" 3.5' to 5.0'	24" 2.0'	24" 2.0'	36" to 60" 3.0' to 5.0'

four to eight inches near the surface. This surface layer dries out soon after the rainy season.

This soil is used mainly for producing oats and vetch for hay. Field corn is sometimes grown for silage. The site is presently being grazed by cattle.

If drainage is provided and if suitable varieties of crops and careful selection of tree species are planted, the soil will amply support forage, row, truck crops and fairly well support some tree crops (especially if drainage is provided).

Tile drains or open ditches are sometimes used to lower water tables and these help keep it lowered. The drainage on the site is good here because of the slope it is found upon. Trees occupy most of this area and aid stability.

According to soil capability, this soil requires moderate conservation practices, and most limitations are due to the height of the water table. According to the Storie Index, this soil requires special management for most crops.

Goldridge (GdC)

Goldridge fine sandy loam is where seepage areas occur in swales (a slight marshy depression in generally level land) and on footslopes in places on the soil. There are vernal pools present here (see hydrology map).

This soil is used mainly for timber production. On the site, this soil supports Douglas fir and oak trees. This is an excellent area for tree planting. Cleared areas have been used for apple orchards or for pasture, and cattle do graze here.

This soil is suited for forage, field and row crops. Stone fruits and nuts can also be grown, but some varieties are not well suited on soils that are less than five feet deep. This soil is also suited to pasture and timber. All tillage and irrigation must be done across the slope or on the contour to reduce the hazard of erosion. Keeping a good ground cover helps slow the runoff and thus reduce erosion.

The soil capability indicates that severe limitations require special conservation practices. The limitations are mainly due to erosion risks, which are controlled with close-growing plant covers. According to the Storie Index, this soil requires special management needs or a narrow

choice of crops.

Goldridge (GdD)

Goldridge fine sandy loam, also with swales occurring, is used for apple orchards; cleared areas are used for grazing. Other areas can be used for timber production. The Douglas fir and oak trees occur here, and redwoods have been planted on the site. The cattle graze here, and thus, the redwoods have been fenced in to keep them from being grazed.

This soil is suited to dryland and irrigated pasture, field crops, vineyards and orchards. Apple orchards produce well on this soil. Some areas are well suited to timber production; most such soils have been cleared. Careful management enables these suitabilities.

Keeping a cover of vegetation helps to control gullying and sheet erosion during the wet season, and farming on the contour slows runoff and thus reduces erosion. Sprinklers are better to use than other methods of applying irrigated water. A suitable cropping system includes field crops grown in sequence with such cover crops as pasture. On this site, cattle grazing coincides with this information.

According to the soil capability, this soil requires very careful management. The main limitation is risk of erosion, unless close-growing cover plants are maintained. The Storie Index indicates the requirement for special crop management.

Pajaro (PaA)

Pajaro find sandy loam makes up most of the flood plain and thus is rich in alluvium. This soil is used mainly for grazing livestock. Some areas have been seeded for improved dryland and irrigated pasture. A few areas, where drainage problems are less serious, are being developed for urban use. Generally the soil is too wet during the growing season to grow trees for this purpose. On the site, grazing cattle are also well suited to this soil.

The drainage on the site is poor being in a flat floodplain. Putting in artificial drainage here may be difficult because of the high water table, and a suitable drainage outlet is also difficult to obtain in Pajaro soils. According to the soil capability, this soil requires moderate conservation practices. The main limitations are due to water in the soil. The Storie Index indicates the need for special management of crops.

CLIMATE

Climatic data were obtained from the Sebastopol Weather Station at 1015 Martin Lane, which is approximately one kilometer northwest of the site. The records from this station were received through the cooperation of Mrs. Frieda G. Johnson, who was responsible for recording data at the station. Other data were obtained through publications listed in the reference section.

The climate of Sonoma County is characterized by moderate temperatures and precipitation. There are several factors that play important roles in the climate of the Sebastopol area. The most important factor is the Pacific High, a major high pressure area over the northern Pacific Ocean, which changes position with the seasons. Storms in the wet season enter the county due to the southerly position of the high, while in the dry season, when a more northerly position is assumed, storms are routed through the Pacific Northwest. As a result of this, precipitation is concentrated in six months of the winter period with only light amounts recorded during the rest of the year.

AVERAGE MONTHLY AND SEASONAL
PRECIPITATION IN CENTIMETERS
Source: Sebastopol Station

July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
0.05	0.3	0.86	2.97	9.39	14.8	16.0	11.1	9.7	5.0	2.18	0.66

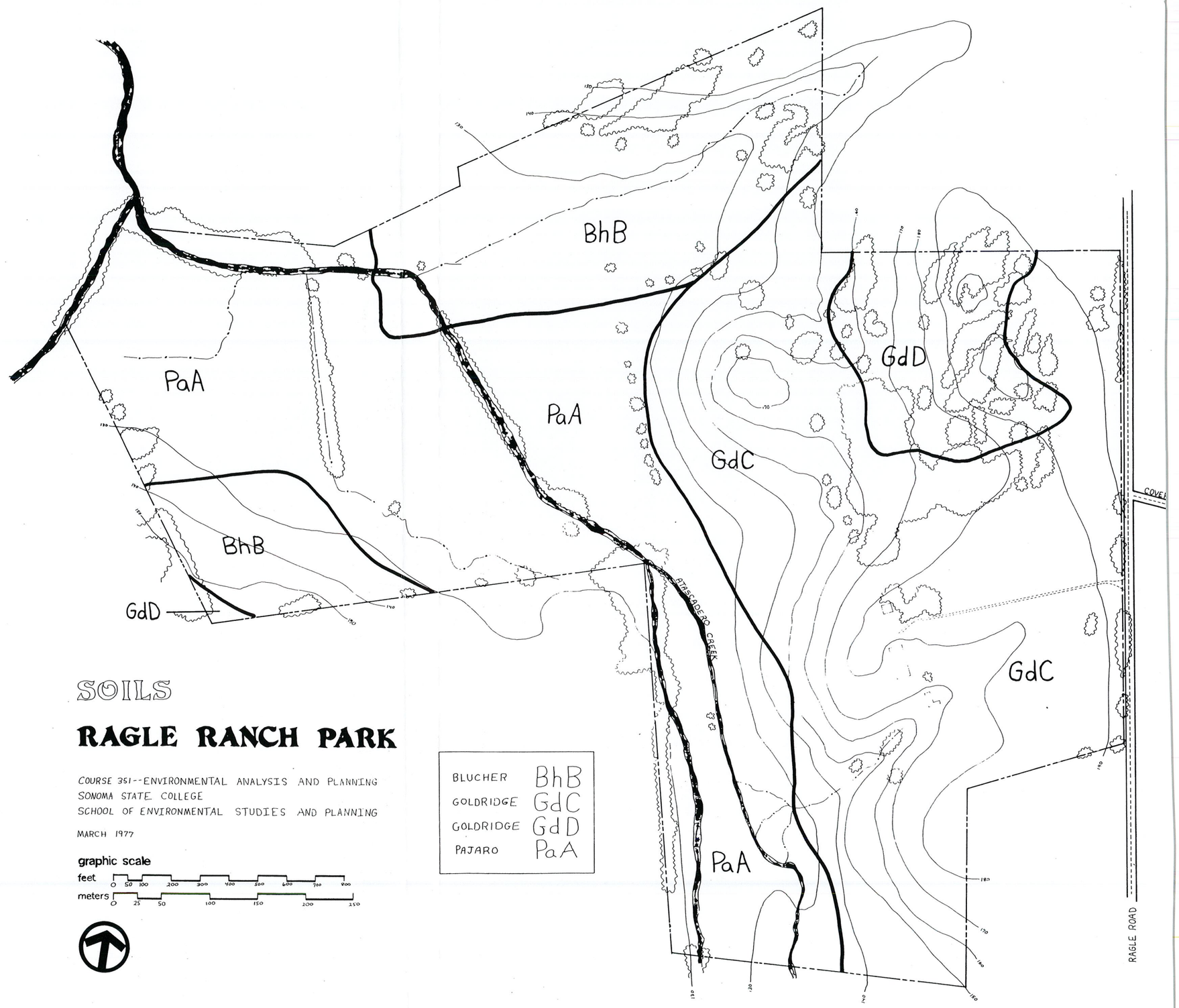
Season
74.01

PROBABILITY OF RECEIVING LESS THAN
INDICATED ANNUAL PRECIPITATION FOR SEBASTOPOL
Source: Climate of Sonoma County, Elford

Units in centimeters:

5%	10%	25%	33%	50%	67%	75%	90%	95%
51.6	56.1	62.7	67.0	74.1	80.3	85.1	95.8	102.9

Another factor influencing the climate is the cold upwelling current of water along the coast--about 10° to 15° F. colder than normal. In the



SOILS

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

BLUCHER	BhB
GOLDRIDGE	GdC
GOLDRIDGE	GdD
PAJARO	PaA

graphic scale

feet 0 50 100 200 300 400 500 600 700 800

meters 0 25 50 100 150 200 250

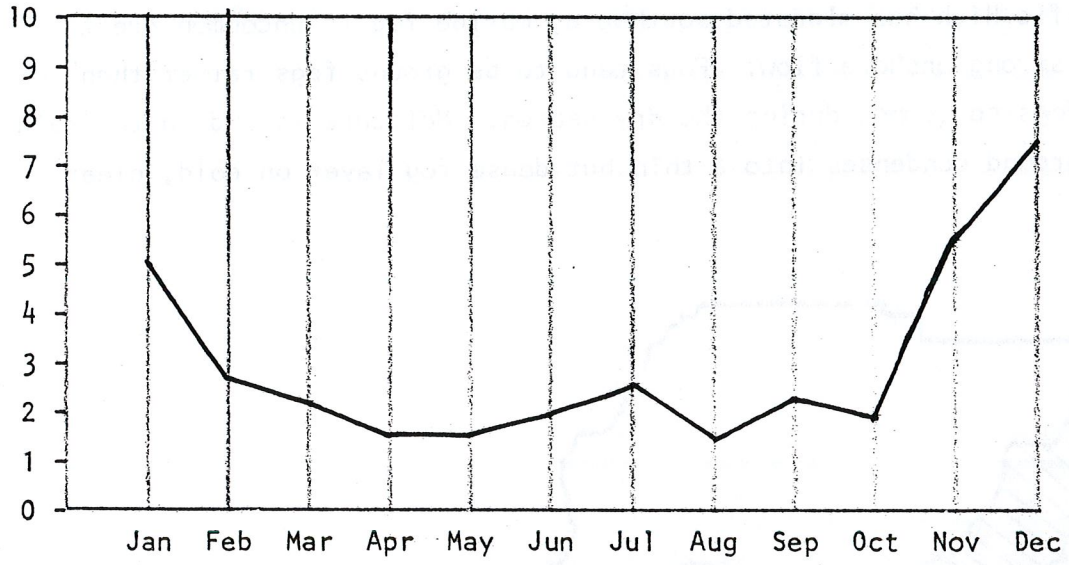
dry season, the onshore winds are cooled by the cold water, causing the formation of fog. The fog then flows through the Estero Lowland, penetrating the Sebastopol area as it flows inland. In the wet season, when the Pacific High has migrated southward, marine fog is uncommon due to lack of strong onshore flow. Fogs tend to be ground fogs rather than marine fogs so common during the dry season. Moisture in and on the rain-soaked ground condenses into a thin but dense fog layer on cold, clear nights.

AVERAGE FOG INTRUSION

Source: Farm and Home Advisor

MEAN FOG DAYS PER MONTH
AT SEBASTOPOL STATION

Graph based on data from January, 1974, to December, 1977:



PERCENTAGE FREQUENCY OF OCCURRENCES
OF SPECIFIED SKY CONDITIONS FOR SONOMA COUNTY

Source: Climate of Sonoma County, Elford

month	clr	sctd clds	high clds	brkn low	ovc low
Jan	28.4	12.6	14.9	5.3	38.8
Feb	33.1	16.9	17.2	9.9	22.9
Mar	30.5	23.3	23.1	5.6	17.5
Apr	35.4	17.0	19.0	9.2	19.4
May	35.7	19.9	15.4	6.1	22.9
Jun	44.3	22.3	9.3	7.3	16.8
Jul	52.8	10.2	3.5	2.6	30.9
Aug	66.6	7.9	1.8	2.5	21.2
Sep	62.8	10.3	4.5	2.6	19.8
Oct	41.0	13.1	8.3	7.8	29.8
Nov	32.6	16.6	16.4	8.8	25.6
Dec	25.3	14.8	22.0	6.4	31.5

explanation of headings

clr: less than 1/10 sky covered with clouds

sctd clds: not more than 5/10 cloudiness

high clds: 5/10 or more high cloudiness with no more than 5/10 low clouds

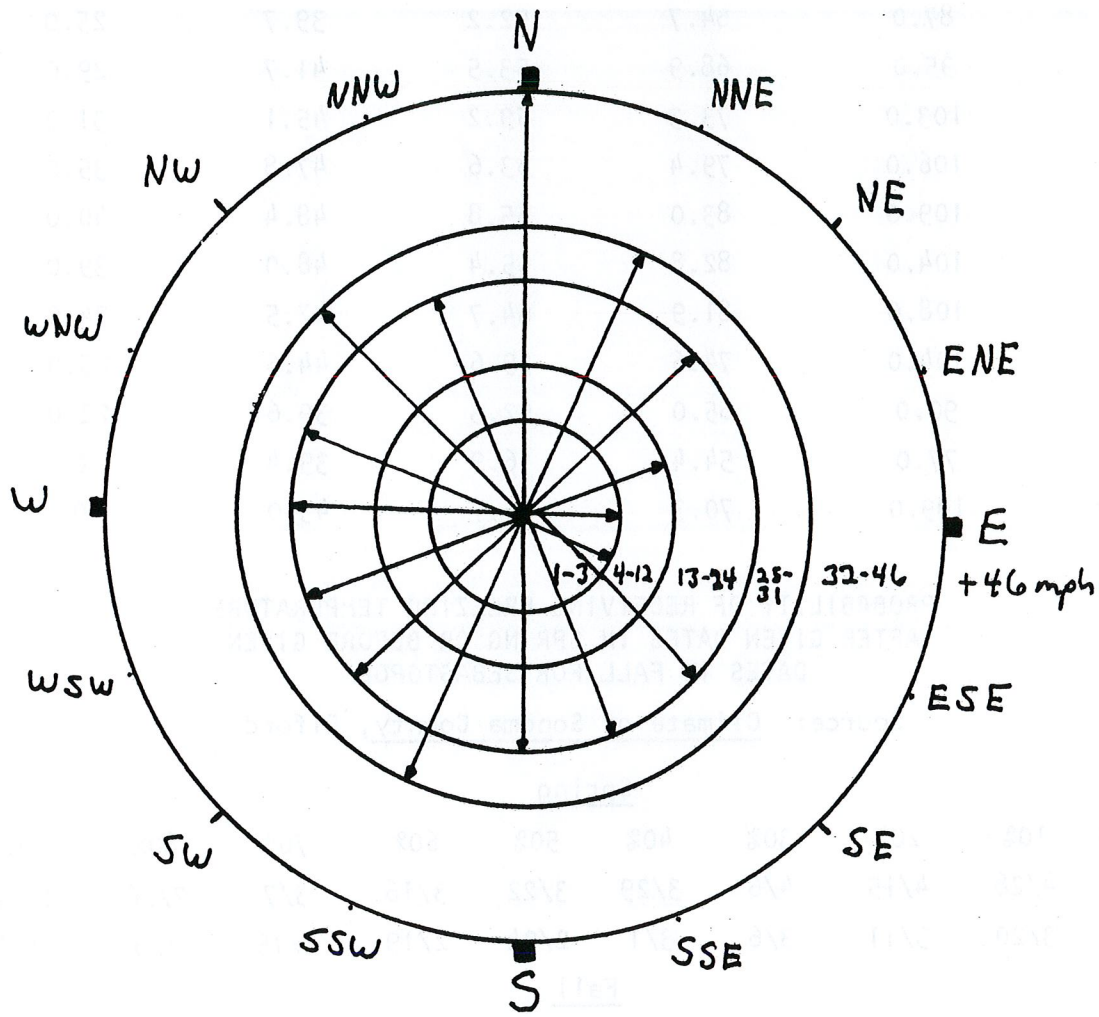
brkn low: more than 5/10 but no more than 9/10 low cloudiness

ovc low: more than 9/10 low cloudiness

In the dry season, winds are generally from the northwest and are caused by the position of the Pacific High and the inland low pressure area. The wet season brings lower temperatures, higher precipitation, increased cloud cover and a change in primary wind direction. The more southerly position of the Pacific High during this season allows storms to pass through the region. Southerly winds which occasionally exceed 30 miles per hour are associated with storms due to the cyclonic pattern of air flow into the low pressure areas.

HIGHEST RECORDED WIND VELOCITIES
FOR SONOMA COUNTY

Source: Climate of Sonoma County, Elford



The coastal range of mountains east of the Russian River provides a barrier that protects Sonoma County from the very hot weather of the

central valley during the summer months. The nearby Pacific Ocean provides a source of cool, moist air that keeps temperatures generally cool although high temperatures sometimes exceed 100° F. in the summer. Maximum winter temperatures are relatively mild, while minimum temperatures are generally near or slightly below freezing.

TEMPERATURE MEANS AND EXTREMES
IN DEGREES FAHRENHEIT

Source: Sebastopol Station

	Highest	Mean Maximum	Mean	Mean Minimum	Lowest
Jan	75.0	55.1	45.7	36.3	18.0
Feb	80.0	55.9	49.1	38.3	22.0
Mar	87.0	64.7	52.2	39.7	25.0
Apr	95.0	68.9	53.5	41.7	29.0
May	103.0	73.3	59.2	45.1	31.0
Jun	106.0	79.4	63.6	47.8	35.0
Jul	109.0	83.0	65.8	48.4	40.0
Aug	104.0	82.8	65.4	48.0	39.0
Sep	108.0	81.9	64.7	47.5	34.0
Oct	104.0	74.6	59.6	44.6	25.0
Nov	90.0	65.0	52.3	39.6	22.0
Dec	77.0	54.4	46.9	39.4	0
Year	109.0	70.3	56.7	43.0	0

PROBABILITY OF RECEIVING FREEZING TEMPERATURE
AFTER GIVEN DATES IN SPRING OR BEFORE GIVEN
DATES IN FALL FOR SEBASTOPOL

Source: Climate of Sonoma County, Elford

Spring

temp	10%	20%	30%	40%	50%	60%	70%	80%	90%
32	4/28	4/15	4/6	3/29	3/22	3/16	3/7	2/26	2/14
28	3/20	3/11	3/6	3/1	2/24	2/19	2/15	2/9	1/31

Fall

temp	10%	20%	30%	40%	50%	60%	70%	80%	90%
32	10/22	10/28	11/2	11/5	11/9	11/13	11/17	11/22	11/28
28	11/8	11/18	11/24	12/1	12/6	12/12	12/19	12/26	12/31

AIR QUALITY

The Sebastopol area, as well as the rest of the county, has a persistent temperature inversion caused by the cool marine air near the ground. This tends to trap and concentrate pollutants generated by vehicles and other emission sources. It is strongest during the summer but can also occur on clear winter nights when radiation causes a cool layer of air to form at the ground surface.

Fortunately, the west-to-northwest winds of the dry season bring clean air to the area and help blow away or dilute pollutants. The quality of the air in Sebastopol is still good relative to the rest of the Bay Area.

EFFECTS OF CLIMATE

The combination of marine influence and moderate temperatures typical of Sonoma County cause the climate of the Ragle Ranch area to be conducive to coniferous forest and oak woodland communities. The removal of the natural vegetation in the area brought about subtle microclimatic effects, including a larger variation in temperature, greater effects from wind, and higher soil evaporation. Because the ranch consists of two main types of topography--flatlands of the creek basin and the rolling hills of the higher elevation--different microclimatic effects exist on the property. The creek basin, because of the abundance of water, is more vulnerable to ground fog than the higher elevations on the site. In turn, higher elevations are subject to more severe effects from the wind than the lowlands.

Because of the area's unique climatic characteristics, it is suitable for several types of agriculture. Some crops grown commercially in the area are the Gravenstein apple, grapes, prunes and peas. Barley and potatoes have also been grown in the past.

Recreation is also affected by climate. Because of the mild climate, many types of recreation are suitable for the area. Some considerations affecting recreation on the site would include rain and overcast conditions during the winter months and summer fog intrusion.

HYDROLOGY

Hydrological information was obtained from the Sonoma County Water Agency, State of California Department of Water Resources and Department of Health, and the Sonoma County Planning Department.

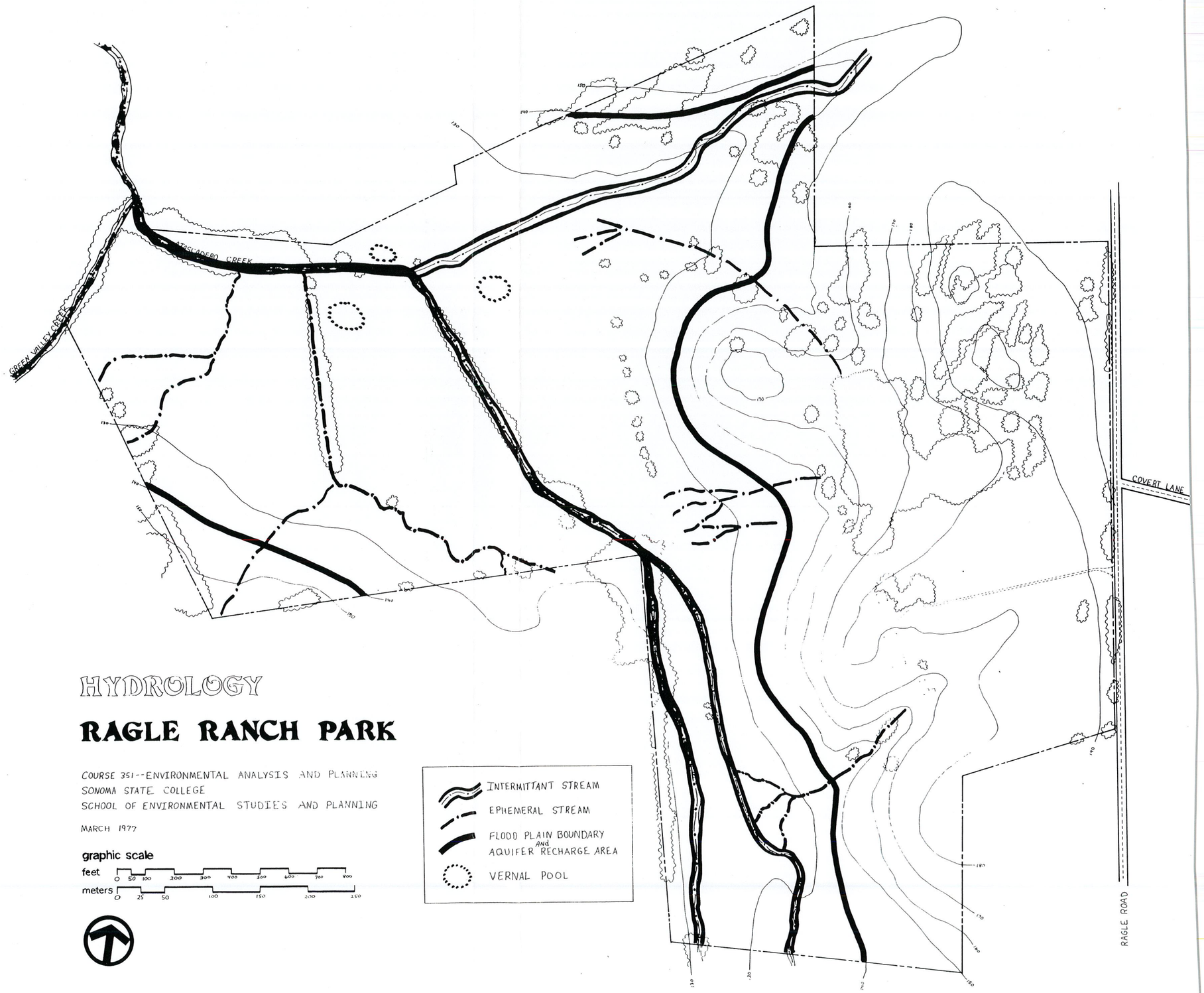
The most significant hydrological factor on Ragle Ranch is Atascadero Creek, which flows in a northerly direction through the property. There are also several ephemeral streams running toward the creek on the property, and there are a few vernal pools along the creek area. Downstream it connects with the Green Valley Creek, which empties into the Russian River. Atascadero Creek is an intermittant stream, usually becoming dry in the summer months (Russian River Study). In the rainy season, the creek is vulnerable to flooding. The 100-year flood flow for the creek is 6,435 cubic feet, and the flood level reaches up to about the 140-foot level of the creek basin. The flat area surrounding the creek, however, is vulnerable to flooding several times a year (Sonoma County Water Agency).

The basin through which the creek flows is an aquifer recharge area which allows the infiltration of water into the groundwater table at a rate greater than .7 acre foot per day (California Department of Water Resources). The aquifer recharge area and the 100-year floodplain occupy the same approximately area (Sonoma County Water Agency).

In 1947 the Sonoma County Soil Conservation Service deepened the creek through Ragle Ranch. The reasons for the channelization were to aid in the drainage of a swamp area upstream, to increase the flow capacity of the creek during the rainy season, and to lower the very shallow water table in the area.

The water quality of Atascadero Creek is poor mainly because of runoff from adjacent pastures grazed by livestock. The mean total coliform count for Atascadero Creek is high at 2,258 per 100 milliliters, and the dissolved oxygen level is only 31 percent of saturation (Russian River Study).

Ragle Ranch lies on the Merced formation, which is one of the principal water-producing geological formations in Sonoma County. The formation consists of massive beds of fine to very fine grained sandstone which is exposed over a broad area extending from Petaluma on the south to the Russian River and from the west edge of the Santa Rosa Plain



HYDROLOGY

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

westward to beyond Occidental. The Merced formation produces large quantities of groundwater. The specific yield of the formation ranges from 10 to 20 percent, an unusually high value. This high specific yield is due to the preponderance of even-grained sand found in wells to depths of over 120 meters. Yields of wells tapping this formation frequently produce up to 3,780 liters per minute (California Department of Water Resources).

Groundwater in the Merced formation is of excellent quality and varies from calcium bicarbonate and magnesium bicarbonate to sodium bicarbonate in composition. Wells tapping unoxidized (blue) sandstone may yield water containing excessive amounts of iron and manganese (California Department of Water Resources).

BIOLOGICAL ANALYSIS OF RAGLE RANCH

Disturbed Grassland Community

It is at the southeast quarter of the ranch where the disturbed grassland community predominates. The primary factor for the existing vegetation is the grazing activity. The area does not seem to be over-grazed to any extent, but the selective preference for some species has determined the existing species composition. The dominant species are introduced annual grasses, narrow-leaved plantain and red-stemmed filaree. Because of the lack of rain preceding and during this analysis, the species composition of this area may not be indicative of the "normal" composition. Approximately 50 percent of the surface coverage is dominated by the red-stemmed filaree and plantain where in wetter years there would probably be more annual grasses present. The selective grazing has reduced the annual grasses that would otherwise dominate with less grazing pressure and more available water. Still, abundant sky lupines, buttercups, checker bloom, butter and eggs, and California poppies offer a spectacular wildflower show.

There is an abundance of gopher activity in this area. Grasslands usually offer a rich habitat and food sources for burrowing and surface animals, such as gophers, mice, shrews and others providing food for other animals, such as raptorial birds. Rodent activity in turn is constantly aerating and enriching the grassland soils.

Live Oak Woodland

Towards the middle portion of the eastern half of the ranch is found a relatively dense stand of coast live oaks. Here the dominant species is the coast live oak, and most of the population is of a relatively uniform age (approximately 75 to 125 years old). They range from saplings to 36 inches in basal height diameter, and approximately 75 percent is 20 to 24 inches in diameter. There are relatively few saplings, and these are prostrate in form due to grazing. The aerial photographs of this area illustrate the contiguous cover of this stand. The presence of a slight slope variation and historical vestiges of the Douglas fir-redwood forest reflect different species composition in parts of this oak woodland. The southern finger of this woodland is for all practical purposes 100 percent live oaks. Shrub species are generally absent in this area. The shade from the trees favors herbaceous species which do not differ in composition too much from the grassland species. The annual grasses and herbs show more vigor due to the increased upper soil moisture maintained by the trees' shadows. The annual grasses are more abundant than the adjoining disturbed grassland. Miner's lettuce, chickweed, Italian thistle, and sheep sorrel are abundant in contrast to the drier exposed grassland.

The more northern portion of the oak woodland does differ from the southern projection in several respects. Black oak, Oregon oak, willows and madrones compose approximately 30 percent of the trees in contrast to the relatively pure stand of live oaks in the southern portion. The understory species are quite different. Dense stands of wax myrtle and western azalea exist. These are remnants of the Douglas fir-redwood forest. The wax myrtle are tree-like in form after finally escaping the grazing pressure of the cattle. The western azalea is poisonous to stock. Another dense understory species is the Himalayan blackberry. This shrub has formed dense thickets in this community and elsewhere on the site. Poison oak is also well established in this community.

The live oak woodland offers good habitat for many animal species. Scrub jays, bushtits, dark-eyed juncos, white- and golden-crowned sparrows, brown towhees, rufous-sided towhees, black-tailed hares and black-tailed deer were all observed in the area.

Oak Savanna Community

The savanna community is found in the northeast quarter of the site area. The dominant species are live oak and Douglas fir. The Douglas fir composes only 25 percent of the trees with the live oak dominating. The Douglas fir trees are quite old, ranging from 3 to 5 feet in breast height diameter and are vestiges of the forest that existed there until just after 1860. The live oaks, in contrast, are vigorous with diameters from 1.5 to 2.5 feet in diameter. There is little shrub understory competition. The herbaceous ground cover is much like the southern portion of the live oak woodland with annual grasses, miner's lettuce and chickweed. However, little Italian thistle was observed in the area. Following the sloping terrain northward, the live oaks are reduced due to the finer textured soils. Here along the drainage lines hawthorns are becoming established. The highest knoll west of the live oak woodland, which is categorized as disturbed grassland, has many young live oaks. They are becoming established on the southern portion of this knoll. They are restricted to the southern exposure due to the high northwesterly winds of the late spring and summer which affects the germination and potential establishment of this species. At the very apex of this knoll is a small dense population of Scotch broom. The center of this population is escaping the grazing pressure and is well established. This "weed" can form a potentially dense thicket if left unchecked.

The savanna habitat has much the same animals as those of the grassland. The small rodents and burrowers, along with smaller organisms of the surface soils, are a food resource to larger, more mobile animals. Also, the acorns of the live oaks provide a huge food supply for deer, squirrels, mice, jays and woodpeckers. In this particular habitat, many common flickers and several red-tailed hawks were observed. These hawks were often observed perching in the mature Douglas firs.

Northern Oak Woodland

The area described as Northern Oak Woodland lies at the northern boundary of the ranch. It lies at the periphery of the flood plain at a slightly higher elevation than the adjoining wet meadow community. It is definitely in a seral stage of development. The associated Oregon oaks, black oaks and Douglas fir are to be found, but at least 40 percent of the aerial coverage is filled by dense stands of blackberries and

arroyo willows. These indicate a high soil moisture content due to the drainage from the adjoining higher terrain. There are several live oaks at the southern edge of the woodland where there is less competition for light. The herbaceous cover of this area is dominated by annual grasses, bracken fern and sheep sorrel where the dense cover of blackberries and willows is absent.

Again, the dense understory offers a protected habitat for many mammals and birds, as well as a plentiful source of food. Many of the birds found in the dense understory of the live oak woodland were also observed in this area. Several black-tailed hares, black-tailed deer and California gray squirrels were also observed.

In those areas roughly overlaying the floodplain and aquifer recharge are found several more plant communities which have adapted to more favorable, wetter soil conditions. These communities are rush, wet meadow, distrubed riparian, and in small topographical depressions are several vernal pool localities.

Riparian Communities

Both the mixed riparian and disturbed willow riparian woodlands are dominated by two willow species, the arroyo willow and the red willow. The streams have been subject to channelization, straightening, check dams and grazing disturbance. These activities have occurred on the property as well as down- and upstream. The predominance of willows indicates a seral stage of development in both communities. The disturbed willow riparian community is almost wholly dominated by willows. The mixed riparian community has some riparian species, such as bay, black oak, Oregon oak and Oregon ash, but is still dominated by willows. The understory and herbaceous cover in the riparian communities are highly variable. Dense thickets of blackberries, both native and introduced, occupy some areas. Others have little vegetational cover at all due to trampling activities. In some areas are dense growths of duckweed, water fern, water hemlock, tule and other water-loving plants.

The riparian community supports a wide variety of animal life. It serves as habitat for resident fish and amphibians and also as important habitat extensions for many birds and mammals, offering diverse insect and plant food resources, shelter and water. The riparian vegetation forms the base for many food chains and webs. Algae and zooplankton

serve as food for aquatic and semi-aquatic insects which become food sources for other insects, fish and amphibians. These insects serve as a food source for many birds, such as warblers, flycatchers, vireos, yellow-throats and others.

Rush Community

The largest plant community on the site is the rush community. The 100-year floodplain and aquifer recharge areas roughly correspond to the area encompassing the rush and wet meadow communities. The surrounding higher topography and the associated soils and deposits of tuff breccia bedrock allow increased surface drainage into the relatively low-lying rush community. This excess runoff water and the high water table of the aquifer recharge area allows the establishment of the rush and sedges. The rush community is almost solely dominated by the Pacific rush. This is an arbitrary community demarcation in distinction from the wet meadow community. Generally, at least 50 percent of the aerial coverage of this community is dominated by the Pacific rush. However, various species of the disturbed grassland and wet meadow communities are present within this community.

Wet Meadow Community

The wet meadow community is composed of several sedges, rushes and grassland species. The relative frequency of each of these types is approximately equal. In comparison to the rush community, the soil type of the wet meadow is not as fine and is better drained.

Many of the animal species found in the grassland community are present in the wet meadow and rush community. In addition, common snipes and white-tailed kites were observed in the area.

Vernal Pool Locale

Several vernal pool localities are found in the rush community. These lie in small topographical depressions where there is even poorer drainage than the surrounding rush community. The vernal pools found on the property are relatively small, approximately 100 feet in diameter.

Almost half of the rare or endangered plant species of Sonoma County are vernal pool species. This is due to natural causes: The soils and moisture of the vernal pools provide very unique conditions demanding specialization on the part of the plants. On the site, an aquatic

buttercup, *Ranunculus lobbii*, was identified and is on the endangered species list for Sonoma County. Other vernal pool species found were monkey flower, pennyroyal and *Psilocarpus*. It is important that these areas be managed correctly because of the unique biota of this habitat.

Other Communities

The other remaining communities to be distinguished are wholly artificial as a result of man's activities. The old ranch house, barn and other sheds have various introduced herbaceous and woody horticultural varieties around them. These are intermixed with several native trees, such as live oaks and redwoods.

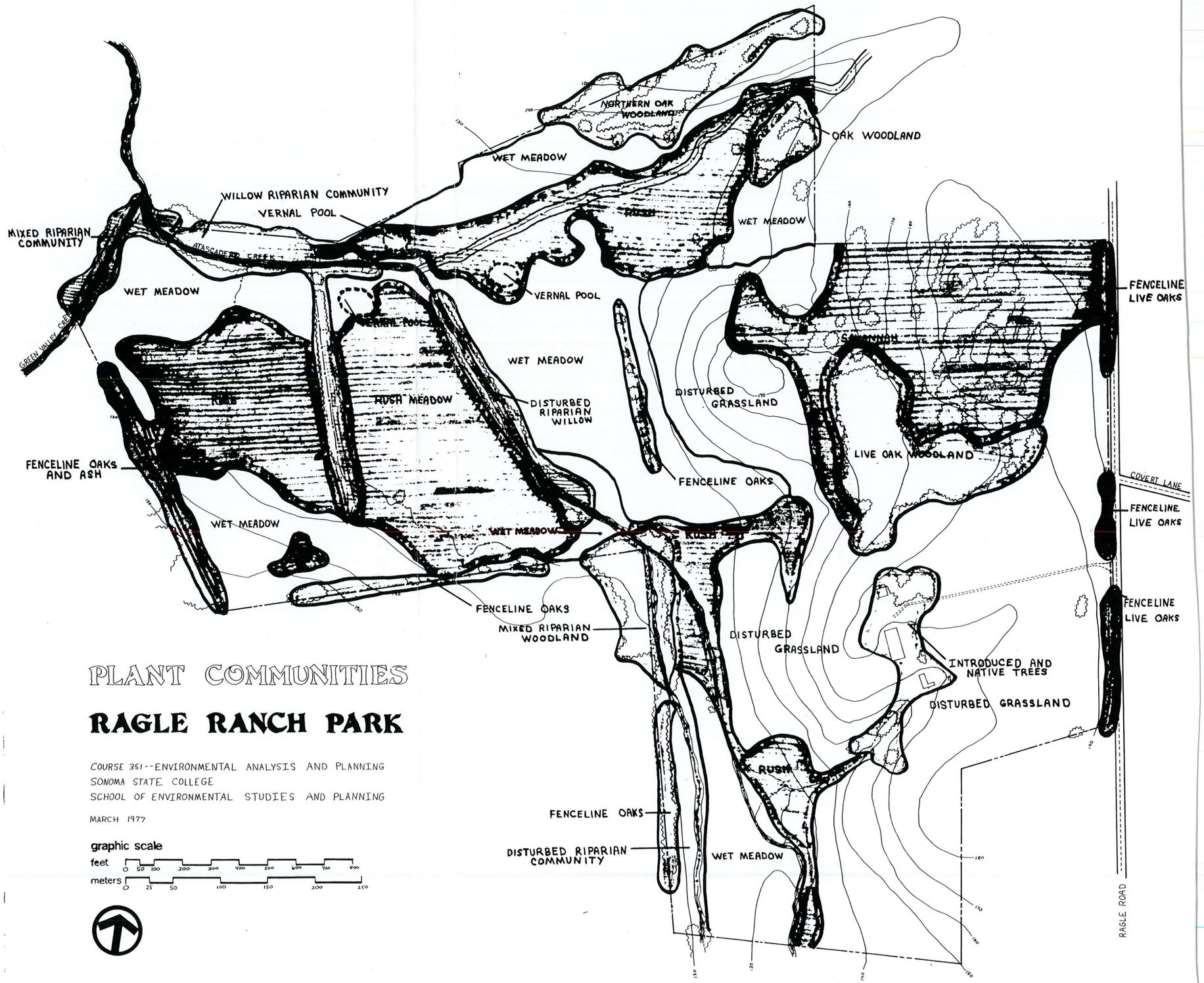
The eastern fence line community is composed primarily of live oaks. The herbaceous cover is dominated by blackberries due to the drainage ditch and resulting available water. Bracken fern and various herbs of the grassland community are found here. Several grassland species not seen in the disturbed grassland are found here and indicate those species which could be present if not for grazing.

At the western extreme of the site is another fence line community of Oregon ash. These fence line trees are quite old and are in poor health; mistletoe is abundant throughout the trees. A young stand of saplings has invaded the site and could be an important successional indicator.

Historical, Ecological and Successional Considerations

Human activities, such as forestry, farming and grazing, have had a major effect upon the distribution and composition of the plant communities. Around 1860 this eastern half of the site was deforested. The historical records, as well as vestiges of a Douglas fir-redwood forest, indicate this activity. The ranch has produced berry, barley, potato and various orchard crops. The remaining orchards, consisting of about 40 trees, are in a state of neglect. The property was last farmed in 1947; barley and potatoes were grown in the wetter rush and wet meadow communities. From 1860 to the present, the ranch has supported 35 to 70 beef and dairy cattle. Grazing is probably the most significant factor in the composition and boundary demarcation of the existing communities.

From the base map it can be seen that a gradual slope exists with the highest relief found at the eastern edge of the ranch and decreasing to the lowest point at the northwest portion of the ranch where Green



PLANT COMMUNITIES

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

graphic scale

feet 0 50 100 200 300 400 500 600 700 800

meters 0 25 50 100 150 200 250

Valley and Atascadero Creeks meet. The eastern portion of the ranch is considerably drier and better drained than the lower drainage and floodplain area found at the western portion of the site. The resulting hydrological character has had a pronounced effect upon the distribution of the plant communities. The deforestation, agricultural and construction activities of the past and present in the surrounding area have contributed eight to nine feet of topsoil in the floodplain area in the past 40 years alone. This deposition of fine-textured soil, the drainage pattern from the surrounding ground, and the present grazing activity have maintained the rush and wet meadow communities which compose 60 percent of the site area.

The 100-year floodplain and aquifer recharge areas roughly correspond to the area encompassing the rush and wet meadow communities. The surrounding higher topography and the associated soils and deposits of tuff breccia bedrock allow increased surface drainage into the lower lying rush community. This excess runoff water and the high water table of the aquifer recharge area allows the establishment of the rushes and sedges. The grazing pressure has restricted the grassland species in these communities. The cattle eat the young shoots of the rushes and sedges, but this does not seem to affect their establishment.

Glenn Ungewitter, former landholder and owner of the stock now grazing the property, has used excellent husbandry practices. The site is healthy and is not overgrazed to any observable extent. Eliminating grazing from the rush and wet meadow areas would allow increased competition from grassland species. On a longer time scale, woody species of shrubs and trees would also invade the area.

The elimination of grazing could also affect the vernal pool species composition. Again, grassland species would invade these areas, competing against the vernal pool species. Even though the cattle may have a negative effect by their trampling and grazing activities, they actually eliminate many competitors for the favorable vernal pool depressions.

The riparian communities, as noted in the plant community descriptions, are in a relatively early seral stage of development. In the last 50 years, the streams on the property have been channelized and diverted several times. At the extreme northwest corner at the confluence of the

Green Valley and Atascadero Creeks is the most developed riparian type community. A recent check dam built on an adjacent vineyard has disturbed even this relatively "developed" area. Several bay, Oregon oak and Oregon ash have been inundated. Barring any other disturbances to the creeks, other riparian species, such as white alder, big leaf maple, valley oaks, black oaks, bay and Oregon ash, would compose a much larger percentage of the total biomass of the riparian community.

The Oregon ash fence line community at the western extreme of the site could offer some clues to the successional direction of several areas found on the site. A dense population of young saplings if found on the site adjacent to the older Oregon ash at the fence line. Another dense stand is found at the northwest corner of the site. This tree could be one of the first woody invaders to the adjoining rush community. Hawthorns are also invading the rush and wet meadow areas.

All of the eastern half of the site would in time successionally develop into the Douglas fir-redwood forest that once dominated this area and much of the surrounding area. Several young Douglas fir are found in the northern oak woodland community indicating the seral stage of development of this community. On a shorter time scale, the elimination of grazing would allow the invasion of many woody plants, such as Scotch broom, coyote brush and live oaks.

The riparian, northern oak woodland and live oak woodland support a diverse and abundant wildlife composition. Even though the dense understory of blackberry and western azalea shrubs in certain areas could constitute a potential fire hazard, these areas offer abundant food and protection for many wildlife species. The vernal pools offer habitat for many of the endangered species of Sonoma County, including an aquatic *Ranunculus* actually identified on the site. Therefore, these areas have a high conservation value.

The Ragle Ranch's biological diversity offers the student and naturalist an excellent opportunity for study and aesthetic appreciation.

RECREATION

At the present there are two parks in Sebastopol that contain recreational facilities. Ives Park offers such facilities as a swimming pool, a lighted baseball diamond, group and family picnic areas, a pond

and a playground for children. Brookhaven Park contains only a playground and a pond, but tennis courts, basketball courts, shuffleboard, a wading pool, amphitheater and picnic grounds are planned for future development.

The population of Sebastopol in 1970 was 13,527. This figure is expected to double by the year 1990 based on county estimates which were prepared for use in developing the Sonoma County General Plan. With this projected increase in population, new recreational facilities will be needed.

Phase I of the Ragle Ranch Park Plan consists of picnic areas, playground, nature trails and a multipurpose turf field. Proposed recreational facilities for Phase II of the plan might include such facilities as lighted baseball diamonds, a handball court, tennis courts, a group picnic area and a community garden complete with a composting operation.

There are numerous horse owners in the rural area of Sebastopol, and the 4-H Club has expressed a need for a public riding arena. There are an estimated 100 4-H Club members in the City of Sebastopol alone. There are no public riding arenas in Sebastopol, and it is proposed that one be included in Phase II of the Ragle Ranch Park Plan.

PART II

MANAGEMENT AND PLANNING RECOMMENDATIONS FOR RAGLE RANCH PARK

FUTURE TRAFFIC CONSIDERATIONS

(Source: City of Sebastopol)

When fully developed, there may be a total of 200 parking spaces on the park site. On a typical summer weekend day, each space might be used 2.5 times. In addition to vehicles using these spaces, it has been estimated that 500 additional people might visit the park on some summer weekends. On one highest visitor day of the year, up to 2,000 people might visit the park, and if the Gravenstein Apple Fair should be allowed to use the site, 5,000 additional people might use the park on each of the two fair days in the late summer or fall.

With the above data and assuming 3.4 persons per vehicle, the daily two-way volume of vehicular trips that would be generated by the park is 1,300 on a typical high visitation summer weekend day and 2,200 on the highest weekend of the year. In the event of the Gravenstein Apple Fair, 5,300 trips per day would occur.*

Although Ragle Ranch will increase the amount of traffic on Ragle Road and Covert Lane, future residential development will cause a substantially greater increase in traffic than that caused by the park site. This residential development will require road improvements regardless of Ragle Ranch. Because of this, Ragle Ranch will not be the direct cause of road improvements for the area.

ENVIRONMENTAL CONSTRAINTS

The map of environmental constraints illustrates the factors that would prohibit various activities and development on the park site. The entire site is unsuitable for septic tank use due to slow percolation rates and the high water table. The constraints on the site consist of:

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*Rather than 3.4 persons per vehicle, 2.5 are assumed for the fair.

(1) floodplain and aquifer recharge area, (2) special biotic areas, and (3) areas subject to erosion and potential landslides with slopes greater than 15 percent.

FLOODPLAIN AND AQUIFER RECHARGE AREAS

The aquifer recharge area and the 100-year floodplain, which occupy the same approximate area, are designated by the vertical lines on the map of environmental constraints. The aquifer recharge area is the area of land where the soil and bedrock conditions allow for the infiltration of water into the groundwater aquifer at a rate greater than .7 acre foot per day. Because of this, no development that would obstruct the infiltration of water, such as pavement, buildings, etc., should be planned for this area. The aquifer recharge area, however, is suitable for passive recreation, such as hiking, informal picnicking, horseback riding, etc. This area is also suitable for grazing and can benefit from it in the following ways: (1) Grazing prevents the overgrowth of vegetation which would decrease the infiltration rate and increase the amount of water lost to evapotranspiration; (2) grazing helps maintain the quality of the vernal pool species by eliminating competition with the grassland species.

The flatlands of the creek basin are vulnerable to flooding several times a year during the rainy season, and the 100-year floodplain reaches up to 140 feet in elevation. Also, because of the alluvial soil deposited during flooding, the area is vulnerable to liquefaction in the event of an earthquake. Over time the settling of the alluvium can result in subsidence of the soil. These hazards prohibit any development in the floodplain zone that would be damaged by flooding, sedimentation or movement of the soil.

SPECIAL BIOTIC AREAS

The areas on the map of environmental constraints delineated by diagonal lines are "special" biological areas. These include vernal pool locales, riparian communities, northern oak woodland, and the western portion of the live oak woodland. Also included is one large relic redwood, a vestige of the Douglas fir-redwood forest that dominated the eastern portion of the site 120 years ago.

The vernal pool areas should be restricted from any active recreational uses. In these localities, many unique species of Sonoma County are found, including the endangered *Ranunculus lobbii* identified on the site. These areas seem to be well adapted to light grazing activity, which eliminates competition with grassland species. Hiking and horse trails could be in close proximity but should not directly encroach upon these areas. These areas are of special scientific and aesthetic value and should be managed carefully.

As previously discussed in the plant community descriptions, the riparian communities offer habitat, food and water for many resident and transient wildlife species. These areas are relatively immature and are not really unique on a county-wide scale, but they do increase the biological diversity on the site. Therefore, these areas should have a high conservation value. Passive recreational uses, such as hiking, picnicking and limited horseback riding, would be appropriate uses. Bridges should be constructed for breachment of the streams by equestrians. All riding trails should have buffer zones between the riparian communities and the riding trails. Barring any other stream disturbances, the elimination of grazing would allow the development of a more typical climax riparian community.

As described in the community descriptions, the northern oak woodland and the western portion of the live oak woodland offer food and habitat for wildlife species. The northern oak woodland is not unique on a county-wide scale but does increase the diversity found on the site. The western portion of the live oak woodland has understory species of wax myrtle and western azalea which are vestiges of the Douglas fir-redwood forest. These are unique in historical and successional terms and should be protected. The dense understory composition of these woodlands restricts many potential recreational uses but offers much to the student and naturalist.

The old Douglas fir trees found in the savanna community are not mapped as special biological areas but are unique in an historical sense. These are relics of the Douglas fir-redwood forest. Due to their poor health, they may present a potential safety hazard as older limbs fall off. However, these trees are favorite perching spots for many of the raptorial birds observed on the site. This should be considered before

any of these trees are removed for construction activities or safety reasons.

Another consideration is the presence of fence posts found in the area. These may have both positive and negative features. The posts may prove unsafe or unaesthetic; however, they do offer perching spots for birds, material for historical study and an opportunity for successional studies of lichens. In the future, these lichens, which are very susceptible to pollution, may be valuable indicators of air quality in the area.

AREAS SUBJECT TO EROSION AND POTENTIAL LANDSLIDES

(Slopes greater than 15 percent)

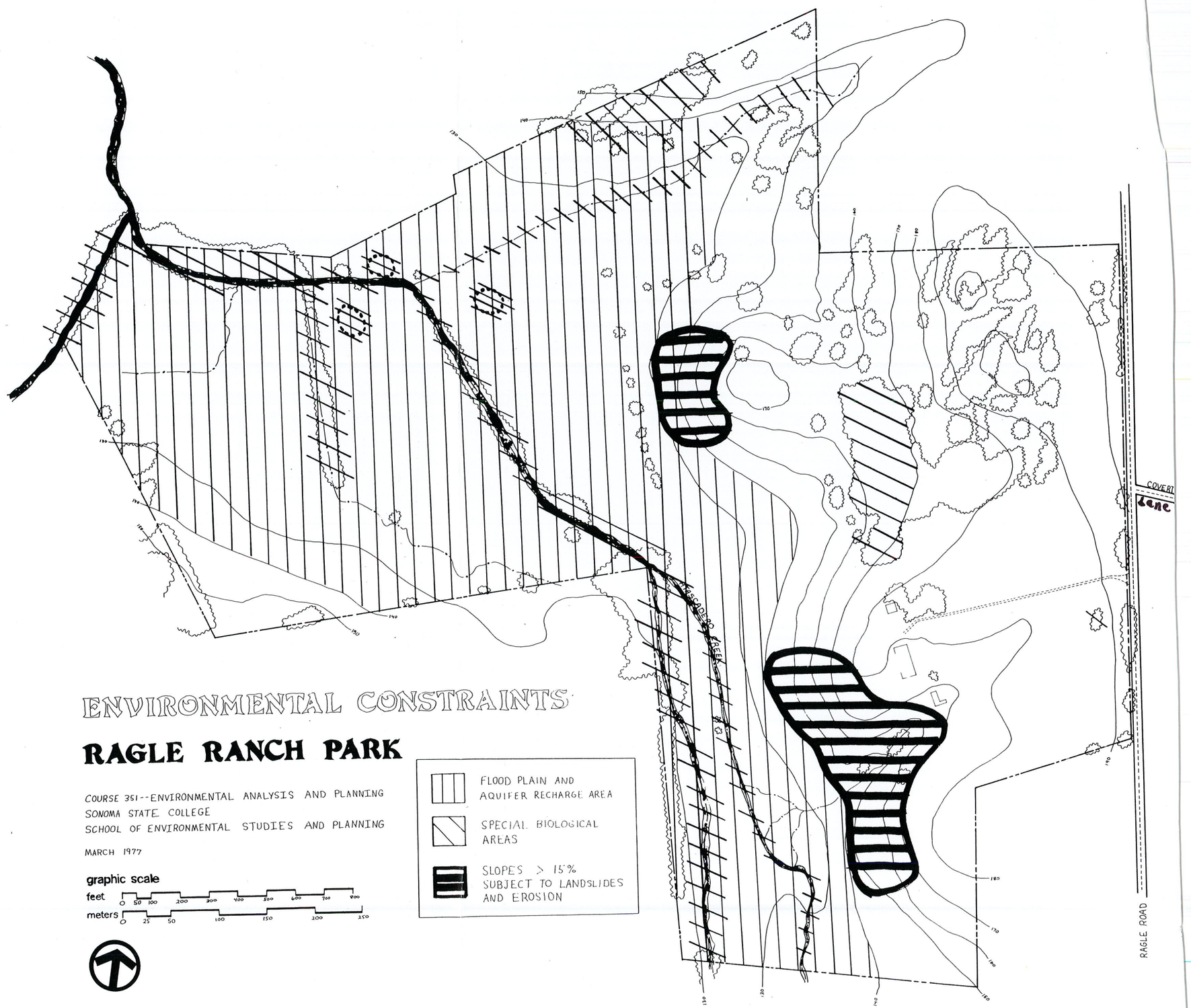
The areas subject to erosion and potential landslides with slopes greater than 15 percent are delineated on the map of environmental constraints by horizontal lines. The construction of buildings on slopes of this sort is difficult and expensive. Scarps are found in this area, as well as some drainage patterns. This area should be planned for passive recreation only.

An additional factor affecting the site is the presence of winds. In the summer months, winds are usually from the northwest, and in the winter months, southerly winds exceeding 30 miles per hour are sometimes present. Consideration should be given in the planning of activities that would be affected by the wind, such as the location of picnic areas, the problem of dust from a horse arena, and the effects of wind on athletic events.

RECREATIONAL SUITABILITY

The map for recreational suitability indicates those areas in terms of their restrictions and the resulting suitability for various recreational activities. Five categories pertaining to intensity of use are indicated. These categories are derived from the environmental constraints and the degree slope found in those areas above the floodplain (see Table 1). The five suitability categories are conservation, passive recreation, active-low density recreation, active-medium density recreation, and active-high density recreation.

The conservation areas have special biological significance and are discussed in the environmental constraint section. These areas are



ENVIRONMENTAL CONSTRAINTS

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

TABLE 1

RECREATIONAL SUITABILITY

Degree of Limitations and Soil Textures Pertaining to Recreational Use*

	SLOPE	UTILITY BUILDINGS	INTENSIVE CAMPSITES	PICNIC AREA	INTENSIVE PLAY AREAS	TRAILS & PATHS
Blucher (BhB)	2%-5%	slight-moderate	slight-moderate	slight-moderate	moderate	slight-moderate
Goldridge (GdC) (GdD)	2%-9%	slight	slight	slight	slight	slight
	9%-15%	slight-moderate	slight-moderate	slight-moderate	slight-moderate	slight-moderate
	15%+	moderate-severe	moderate-severe	moderate	moderate-severe	moderate
Pajaro (PaA)	0-2%	very severe	moderate	slight-moderate	moderate-severe	slight-moderate

These soils are rated on the basis of four classes of soil limitations:

Slight: relatively free of limitations or limitations easily overcome.

Moderate: limitations need to be recognized but can be overcome with good management and careful design.

Severe: limitations severe enough to make use questionable.

Very Severe: extreme measures are needed to overcome the limitations and usage is generally unsound and not practical.

illustrated without any vertical, horizontal or diagonal lines.

The passive recreation area roughly corresponds to the floodplain and aquifer recharge area and is illustrated by vertical lines. These areas are subject to flooding and the resulting deposition of alluvial soils. Therefore, use would be assumed to be of a seasonal nature, construction activities would be restricted, and paved trails would require a high degree of maintenance.

Above the floodplain level, three categories suitable for active use have been designated. It is important to note that within these areas two areas designated for conservation purposes exist, the northern oak woodland and the western portion of the live oak woodland.

*Source: Rutledge, 1971

The three categories of areas designated for active use are derived from the degree of slope and the resulting drainage patterns. Those areas illustrated by diagonal lines running northwest to northeast are areas with slopes 15 percent or greater. They are subject to erosion and potential landslides. Therefore, construction activities would be difficult and costly and would require a high degree of maintenance. For all practical purposes, these areas should be considered areas of passive recreation, but due to their close proximity to areas suitable for high density and medium density use and their lack of restrictions regarding seasonal flooding, they are designated as low density active use areas. Recommendations for this area include informal picnicking and hiking. Equestrian use should be avoided.

Areas designated as suitable for medium density use are indicated by lines running southwest to northeast and are areas of slope between 9 and 15 percent. Drainage from the higher topographic areas exclude high density use.

Areas designated as suitable for high density active recreation use are illustrated by horizontal lines. Two sub-categories are inherent in this area--those with woody vegetation and those without this vegetation. The disturbed grassland in this area is most suitable for intensive recreational use and is virtually free of environmental constraints. The oak savanna and oak woodland areas are intrinsically suitable for high density picnicking, hiking, children's playgrounds, etc. Limited facilities, adjoining parking areas and maintenance roads could be accommodated in this area.

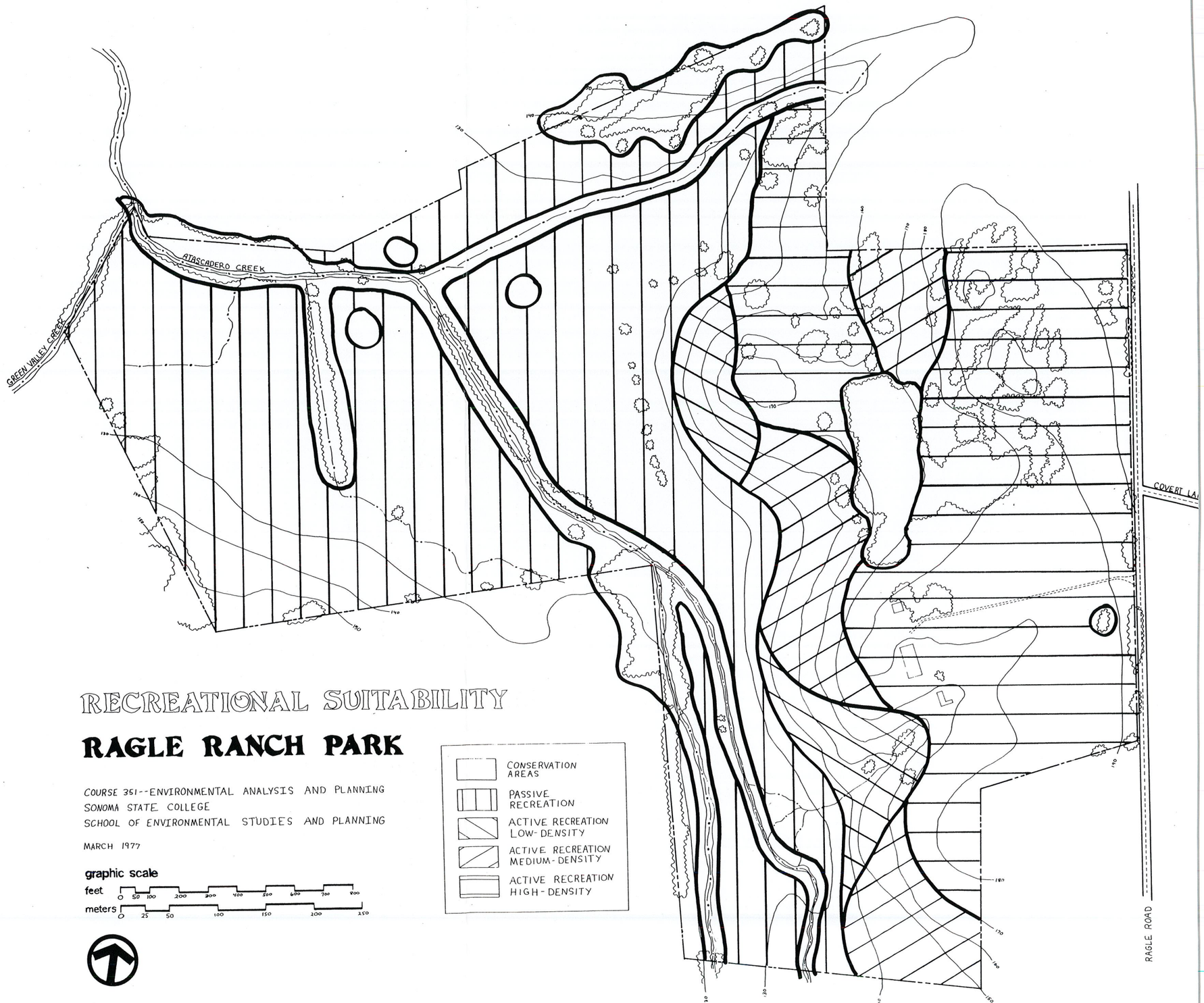
RECOMMENDATIONS FOR PLANNING

Ragle Ranch Park will not only serve the City of Sebastopol's increasing recreational needs but will also act as a buffer zone between the increasing urban sprawl and the threatened rural nature of the area.

The recreational suitability map recommends the concentration of recreation facilities in the eastern portion of the site because:

1. Soils and slopes are suitable for structures, parking lots and intensive recreational use.

2. There will be little impact on the existing biological resources by utilization of the disturbed grassland, which is common and able to



RECREATIONAL SUITABILITY

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

withstand intensive use.

3. It is above the floodplain.

4. Road access and utilities are in close proximity to the area.

5. People can use several recreational facilities in a close proximity to this area.

6. The sketched location of the picnic area, tennis courts and organized league playing fields are protected from the sun and prevailing northwesterly winds.

7. It will protect the endangered species in the vernal pool locales and the other biological resources, such as the riparian habitat, by limiting use in the lower areas.

8. Grazing can still be accommodated in the lower floodplain area.

9. Concentration of activities will facilitate construction and minimize maintenance costs.

RECOMMENDATIONS FOR RECREATIONAL ACTIVITIES

The area designated on the sketch plan as the high density formal group picnicking area is in close proximity to the tentative road, facilities and turf fields. The tree cover provides shade and protection from the prevailing northwesterly winds. This area is approximately four acres and could accommodate large groups of people. Recommended density according to State Park guidelines is a maximum of 30 units per acre, with an average of 6 people per site.

The area designated for medium density picnicking use is approximately six acres. The recommended density according to State Park guidelines is a maximum of 20 units per acre, with about 4 people per site.

Informal picnicking can be accommodated in all seasons on the entire area above the floodplain. The floodplain is suitable for this low density use during the drier parts of the year.

ORGANIZED SPORTS ACTIVITIES

Organized league activities, such as baseball, soccer, tennis and football, etc., can be accommodated in the disturbed grassland area. This area is relatively free of environmental constraints. To maximize use of this area, the outfield portion of one of the proposed baseball

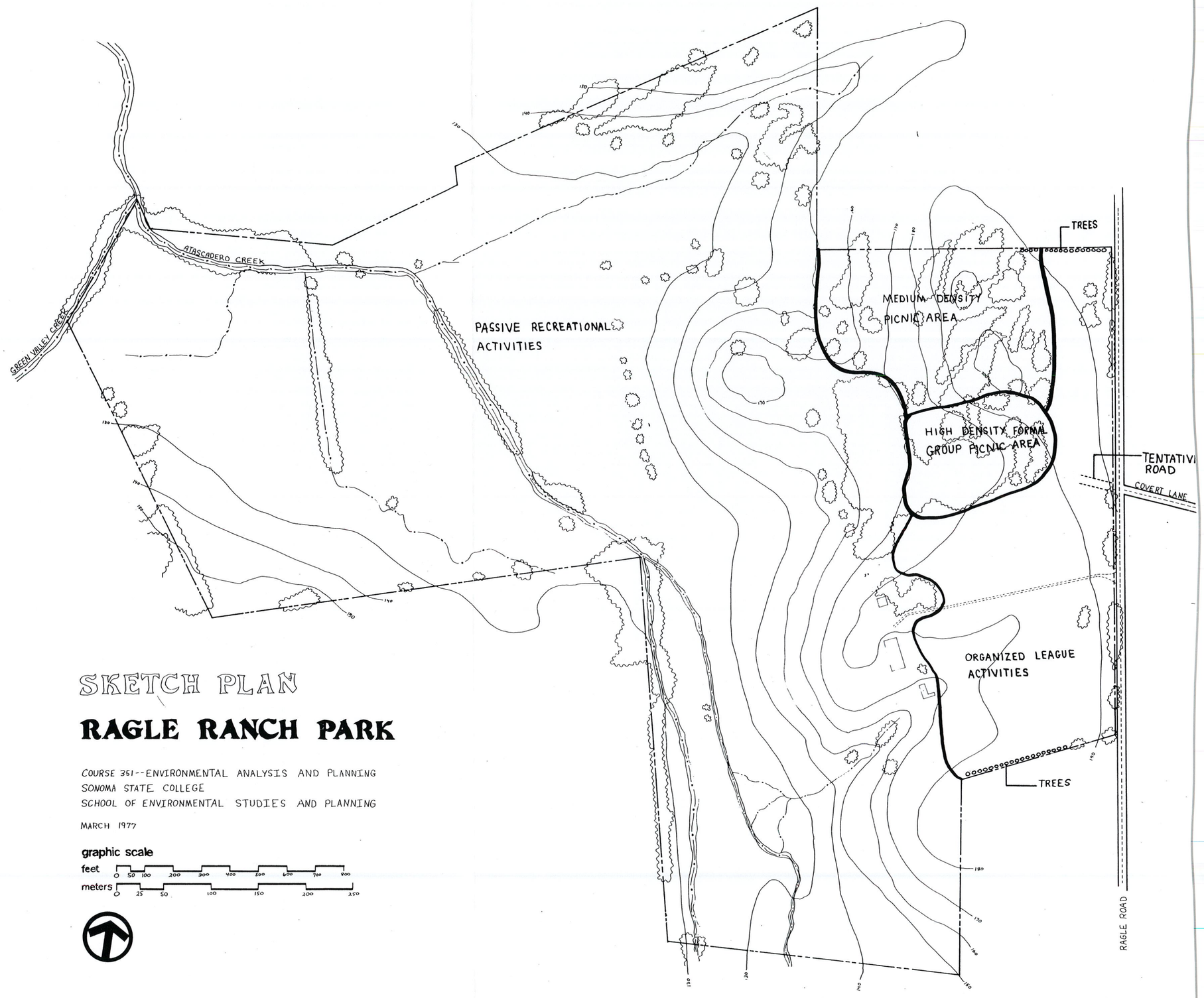
fields could double as either a football or soccer field by planning an overlap in the placement of these fields.

EQUESTRIAN USE

The 4-H Club of Sebastopol and a recent Boy Scouts survey have indicated the need for a public riding arena. The placement of a riding arena should consider the predominant wind direction due to the dust and odors resulting from this activity. Trees could be planted to buffer these effects. Riding activities outside the arena should be planned so as to avoid biologically significant areas and the slopes which are subject to erosion and potential landslides. The poor drainage in the floodplain area should be considered in planning any riding trails.

RECOMMENDATION FOR CONSTRUCTION AND MAINTENANCE

No construction should be planned in the floodplain area due to siltation, liquefaction, subsedence and the regular occurrence of flooding. The relatively level areas lacking extensive tree cover on the eastern portion of the site are compacted and are suitable for construction. The existing well in this area could possibly be utilized for irrigation of organized league playing fields. To allow infiltration of rainwater and to prevent excess runoff, which is directly related to erosion, the amount of pavement should be limited.



SKETCH PLAN

RAGLE RANCH PARK

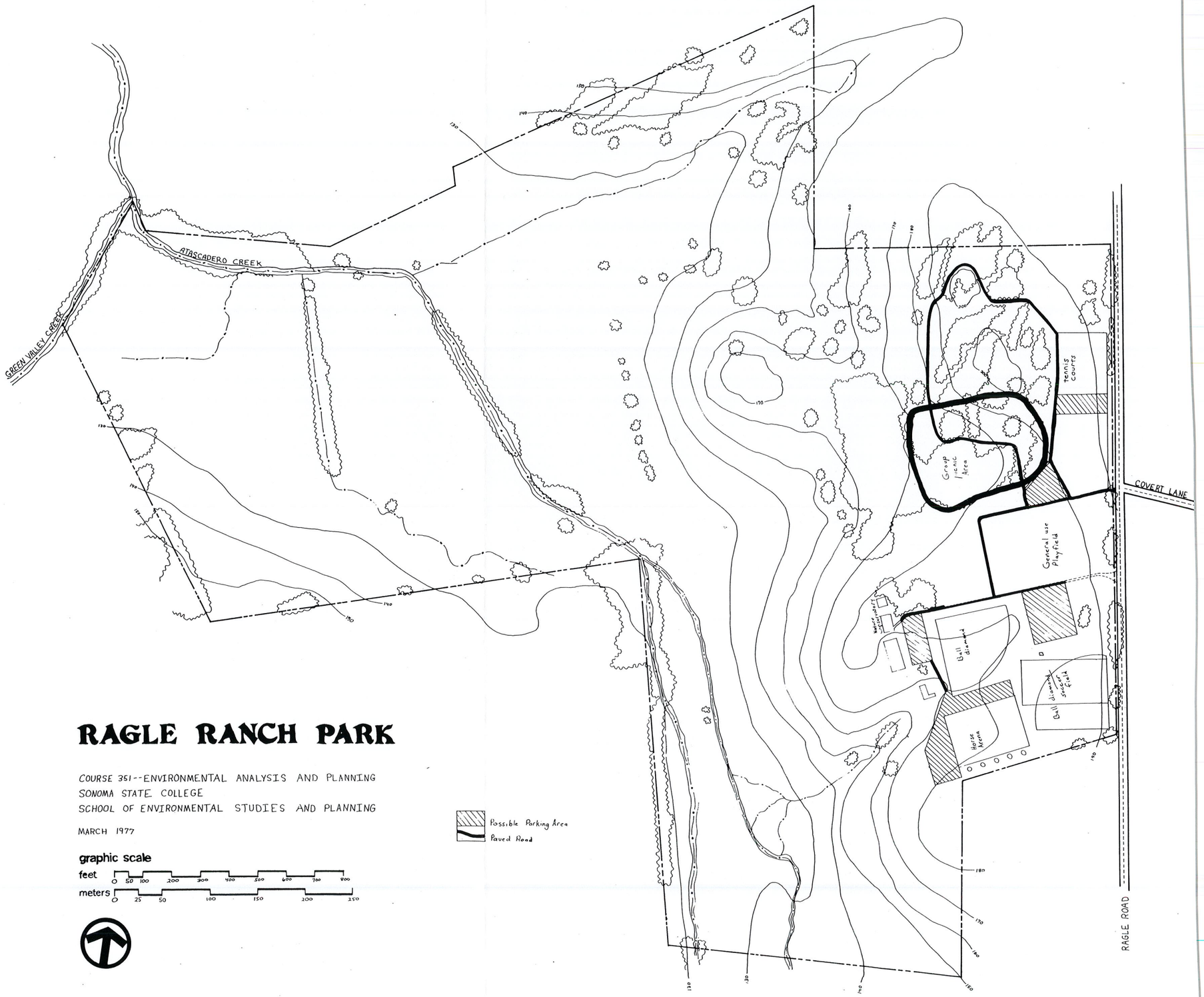
COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977

RAGLE RANCH PARK

COURSE 351--ENVIRONMENTAL ANALYSIS AND PLANNING
SONOMA STATE COLLEGE
SCHOOL OF ENVIRONMENTAL STUDIES AND PLANNING

MARCH 1977



APPENDIX A

Source: Mineral Information Service, March, 1970

SANTA ROSA EARTHQUAKE HISTORY, 1855–1967

Quality: A = excellent quality of epicenter determination, B = good, C = fair, D = poor.
Times are Greenwich time, seven hours later than Pacific Daylight Time, eight hours later than Standard Time.

Only earthquakes whose epicenters are in the Santa Rosa area are included.

Month Day Year	Hour Minute Second	Latitude	Longitude	Quality	Magnitude	Number of stations recording	Felt	Maximum intensity, comments
8/26/1855	21- 0- 0.	38.25	122.67	D			F	Petaluma.
8/27/1855	23- 0- 0.	38.25	122.67	D			F	VI Petaluma.
1/28/1856	11- 0- 0.	38.25	122.67	D			F	Petaluma.
[illegible]	[illegible]	38.25	122.67	D			F	VI Sonoma County.
9/ 9/1859	17-30- 0.	38.25	122.67	D			F	IV Petaluma. Two shocks.
1/ 9/1865	15- 0- 0.	38.42	122.75	D			F	V Santa Rosa.
3/ 5/1865	0- 0- 0.	38.25	122.67	D			F	Petaluma. Night.
3/ 8/1865	14-30- 0.	38.42	122.75	D			F	VIII Santa Rosa, Petaluma, and Napa.
4/23/1868	0- 0- 0.	38.58	122.83	D			F	Healdsburg.
5/ 7/1868	20- 0- 0.	38.58	122.83	D			F	V Healdsburg.
[illegible]	0- 0- 0.	38.42	122.75	D			F	[illegible]
8/25/1871	0- 0- 0.	38.42	122.75	D			F	Santa Rosa.
11/21/1872	0- 0- 0.	38.25	122.67	D			F	Petaluma.
1/ 3/1876	18-55- 0.	38.50	122.83	D			F	VI Santa Rosa, Fulton, Freestone, and Healdsburg.
11/29/1876	1-10- 0.	38.42	122.75	D			F	III Santa Rosa.
1/15/1877	15- 0- 0.	38.42	122.75	D			F	Santa Rosa.
5/31/1878	5-30- 0.	38.42	122.75	D			F	IV Santa Rosa.
5/31/1878	6- 0- 0.	38.42	122.75	D			F	Santa Rosa.
5/31/1878	6-30- 0.	38.42	122.75	D			F	Santa Rosa.
[illegible]	[illegible]	38.50	122.92	D			F	VI Forestville.
9/11/1878	0- 0- 0.	38.25	122.67	D			F	Petaluma. Morning.
8/18/1879	0- 0- 0.	38.42	122.75	D			F	Fiske's Mills.
5/31/1880	0-20- 0.	38.42	122.75	D			F	Glen Ellen.
2/ 7/1882	15- 0- 0.	38.42	122.75	D			F	IV Santa Rosa.
3/ 7/1882	4-30- 0.	38.58	122.83	D			F	Healdsburg.
2/ 6/1885	7- 0- 0.	38.67	122.92	D			F	V Geyser Springs.
2/ 6/1885	10- 0- 0.	38.67	122.92	D			F	V Geyser Springs.
10/16/1885	12-45- 0.	38.42	122.75	D			F	IV Napa and Santa Rosa.
5/12/1887	0- 0- 0.	38.25	122.67	D			F	Petaluma.
12/ 5/1887	13-30- 0.	38.25	122.67	D			F	V Petaluma.
12/26/1887	8- 0- 0.	38.42	122.75	D			F	V Santa Rosa.
1/26/1888	0- 0- 0.	38.58	122.83	D			F	Healdsburg.
11/16/1889	3-55- 0.	38.58	122.83	D			F	Healdsburg, East Oakland, and San Francisco.
6/ 1/1890	21-21- 0.	38.58	122.83	D			F	Healdsburg.
[illegible]	[illegible]	38.42	122.75	D			F	[illegible] shocks.
6/30/1890	0- 0- 0.	38.42	122.75	D			F	Petaluma.
6/30/1890	14- 0- 0.	38.25	122.67	D			F	Santa Rosa. Three earthquakes.
7/28/1890	8- 4- 0.	38.25	122.67	D			F	Petaluma.
10/ 3/1890	20- 5- 0.	38.58	122.83	D			F	Healdsburg.
4/14/1891	7-40- 0.	38.58	122.83	D			F	Healdsburg.
9/23/1891	21-30- 0.	38.58	122.83	D			F	Healdsburg.
2/17/1892	0- 0- 0.	38.50	122.92	D			F	Forestville.
3/13/1892	13-25- 0.	38.25	122.67	D			F	Petaluma.
4/20/1892	9-50- 0.	38.25	122.67	D			F	Petaluma, Roe Island Light House.
9/ 8/1892	12-45- 0.	38.25	122.67	D			F	Petaluma and Napa.
3/28/1893	7-30- 0.	38.42	122.75	D			F	Santa Rosa.
6/18/1893	13- 0- 0.	38.42	122.75	D			F	Santa Rosa.
8/ 9/1893	9-15- 0.	38.42	122.75	D			F	VII Sonoma County. Santa Rosa—the severest since 1868. Petaluma—six shocks. Sonoma, Napa, Healdsburg, San Rafael, San Francisco, Alameda, Sacramento.
9/10/1896	11-45- 0.	38.42	122.75	D			F	Santa Rosa.
10/19/1896	14- 0- 0.	38.42	122.75	D			F	Santa Rosa.
1/ 1/1898	13-15- 0.	38.42	122.75	D			F	Peachland and Santa Rosa.
10/15/1899	5- 0- 0.	38.42	122.75	D			F	VIII Santa Rosa, Petaluma, and Peachland.
1/31/1900	0- 0- 0.	38.42	122.75	D			F	Peachland.
2/ 9/1900	12-30- 0.	38.25	122.67	D			F	VI Petaluma.
3/20/1900	0- 0- 0.	38.42	122.75	D			F	Peachland.
11/13/1900	17-59- 0.	38.50	122.92	D			F	IV Penn's Grove (Penngrove).
3/ 4/1903	0- 0- 0.	38.42	122.75	D			F	Santa Rosa.
2/15/1904	0- 0- 0.	38.58	122.83	D			F	Healdsburg.
8/21/1904	0- 0- 0.	38.58	122.83	D			F	Healdsburg.
10/14/1905	0- 0- 0.	38.42	122.75	D			F	Santa Rosa.

SANTA ROSA EARTHQUAKE HISTORY, 1855–1967

Continued

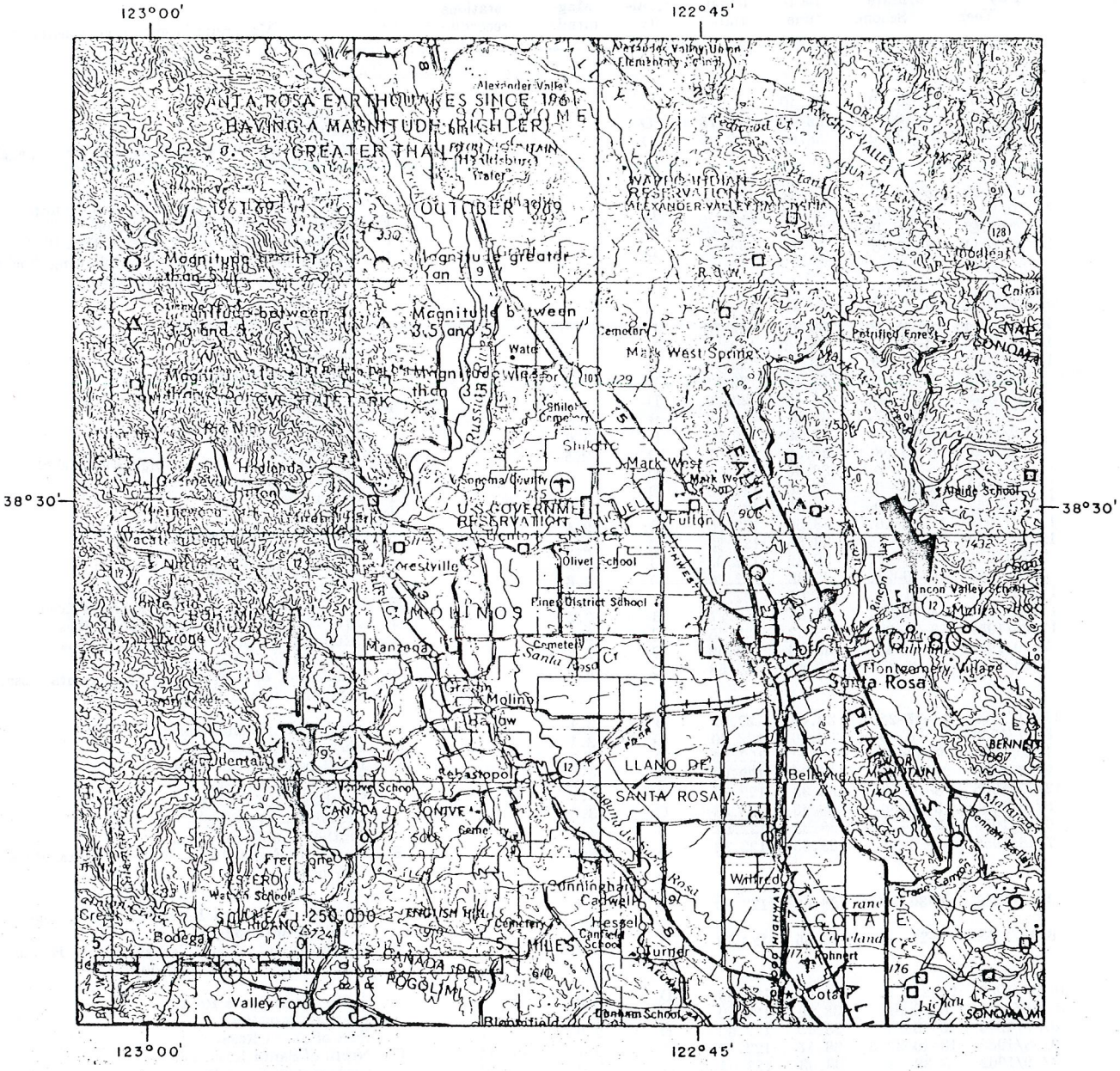
Month Day Year	Hour Minute Second	Latitude	Longitude	Quality	Magnitude	Number of stations recording	Felt	Maximum intensity, comments
12/15/1905	0- 0- 0.	38.42	122.67	D			F	Mercury.
5/ 2/1906	5-19- 0.	38.58	122.83	D			F	Healdsburg.
6/16/1906	0- 0- 0.	38.42	122.75	D			F	Peachland.
6/28/1906	0- 0- 0.	38.42	122.75	D			F	Peachland.
8/ 1/1906	14- 0- 0.	38.42	122.75	D			F	Peachland.
6/30/1907	23-10- 0.	38.42	122.67	D			F	Mercury.
2/ 8/1908	0- 0- 0.	38.42	122.75	D			F	Near Santa Rosa.
2/12/1914	0- 0- 0.	38.42	122.67	D			F	Peachland.
10/ 8/1915	3- 2- 0.	38.42	122.83	D			F	III Sebastopol.
10/ 8/1915	21-20- 0.	38.25	122.67	D			F	III Petaluma.
1/16/1916	0-41- 0.	38.42	122.83	D			F	III Sebastopol.
2/23/1919	22-33- 0.	38.33	122.50	D			F	VI North of Bay Counties. Origin probably in Glen Ellen region. VI at Napa, Petaluma, Santa Rosa, and Point Reyes. Felt also at Sebastopol, San Francisco, Oakland, Stanford University, and Mt. Hamilton.
12/20/1919	9-30- 0.	38.42	122.75	D			F	IV Santa Rosa.
10/ 9/1920	22-11- 0.	38.42	122.75	D			F	III Santa Rosa.
1/ 1/1922	1-10- 0.	38.25	122.67	D			F	Petaluma. Three shocks.
4/ 1/1923	4-19- 0.	38.42	122.75	D			F	II Santa Rosa.
9/ 6/1923	12- 0- 0.	38.42	122.75	D			F	III Santa Rosa.
11/ 8/1923	20-39- 0.	38.42	122.75	D			F	III Santa Rosa.
7/ 6/1924	17-48- 0.	38.42	122.75	D			F	II Santa Rosa.
9/ 1/1924	20-16- 0.	38.42	122.75	D			F	III Santa Rosa.
5/10/1925	13- 4- 0.	38.42	122.75	D			F	II Santa Rosa.
8/22/1925	18-15- 0.	38.25	122.67	D			F	III Petaluma.
4/13/1926	2-20- 0.	38.67	122.92	D			F	IV Geyserville. Rattled doors and windows. Lasted 15 seconds in Healdsburg. Felt in Dry Creek Valley.
4/13/1926	3-20- 0.	38.67	122.92	D			F	Healdsburg.
10/22/1926	13-30- 0.	38.42	122.75	D			F	III Santa Rosa.
10/22/1926	13-51- 0.	38.42	122.75	D			F	II Santa Rosa.
10/27/1926	12- 0- 0.	38.42	122.75	D			F	III Santa Rosa.
9/20/1927	15-40- 0.	38.42	122.75	D			F	III Santa Rosa.
10/ 2/1927	18-55-30.	38.42	122.75	D			F	Santa Rosa.
10/ 2/1927	18-55-40.	38.42	122.75	D			F	II Santa Rosa.
10/ 2/1927	19-22- 0.	38.42	122.75	D			F	II Santa Rosa.
2/18/1929	3-25- 0.	38.42	122.75	D			F	Santa Rosa.
9/11/1929	15- 0- 0.	38.42	122.75	D			F	Santa Rosa.
4/21/1932	12-24- 0.	38.25	122.67	D			F	Petaluma.
10/21/1932	10-30- 0.	38.25	122.67	D			F	III at Petaluma.
2/11/1934	0- 0- 0.	38.40	122.75	D			F	IV Santa Rosa.
2/13/1934	0- 0- 0.	38.42	122.75	D			F	Bay (near Santa Rosa).
2/14/1934	18-43- 0.	38.42	122.75	D			F	V Santa Rosa.
2/14/1934	18-51- 0.	38.42	122.75	D			F	Santa Rosa.
2/14/1934	19-15- 0.	38.42	122.75	D			F	Santa Rosa.
2/14/1934	22-24- 0.	38.42	122.75	D			F	2 miles SE of Santa Rosa. V Santa Rosa.
2/14/1934	22-34- 0.	38.42	122.75	D			F	V Santa Rosa. IV Monte Rio and Sebastopol.
2/15/1934	22-30- 0.	38.42	122.75	D			F	IV Sebastopol.
2/16/1934	5-37- 0.	38.42	122.75	D			F	V Santa Rosa. Also felt at Bay, Fulton, Forestville, Jenner, Kenwood, Rincon Valley, Sebastopol, and Windsor.
2/16/1934	5-47- 0.	38.42	122.75	D			F	Same places as above.
2/16/1934	5-50- 0.	38.42	122.75	D			F	Same places as above.
2/16/1934	6-45- 0.	38.42	122.75	D			F	Same places as above.
2/16/1934	7-30- 0.	38.42	122.75	D			F	Santa Rosa.
2/16/1934	9-31- 0.	38.42	122.75	D			F	Same places as 5-37 above.
2/16/1934	14- 1- 0.	38.42	122.75	D			F	Same places as 5-37 above.
2/16/1934	15- 0- 0.	38.42	122.75	D			F	Santa Rosa.
2/16/1934	15-58- 0.	38.42	122.75	D			F	Strongest of series. Felt same places.
2/18/1934	9- 3- 0.	38.42	122.75	D			F	Santa Rosa.
3/12/1934	16-10- 0.	38.42	122.75	D			F	Santa Rosa.

SANTA ROSA EARTHQUAKE HISTORY, 1855–1967

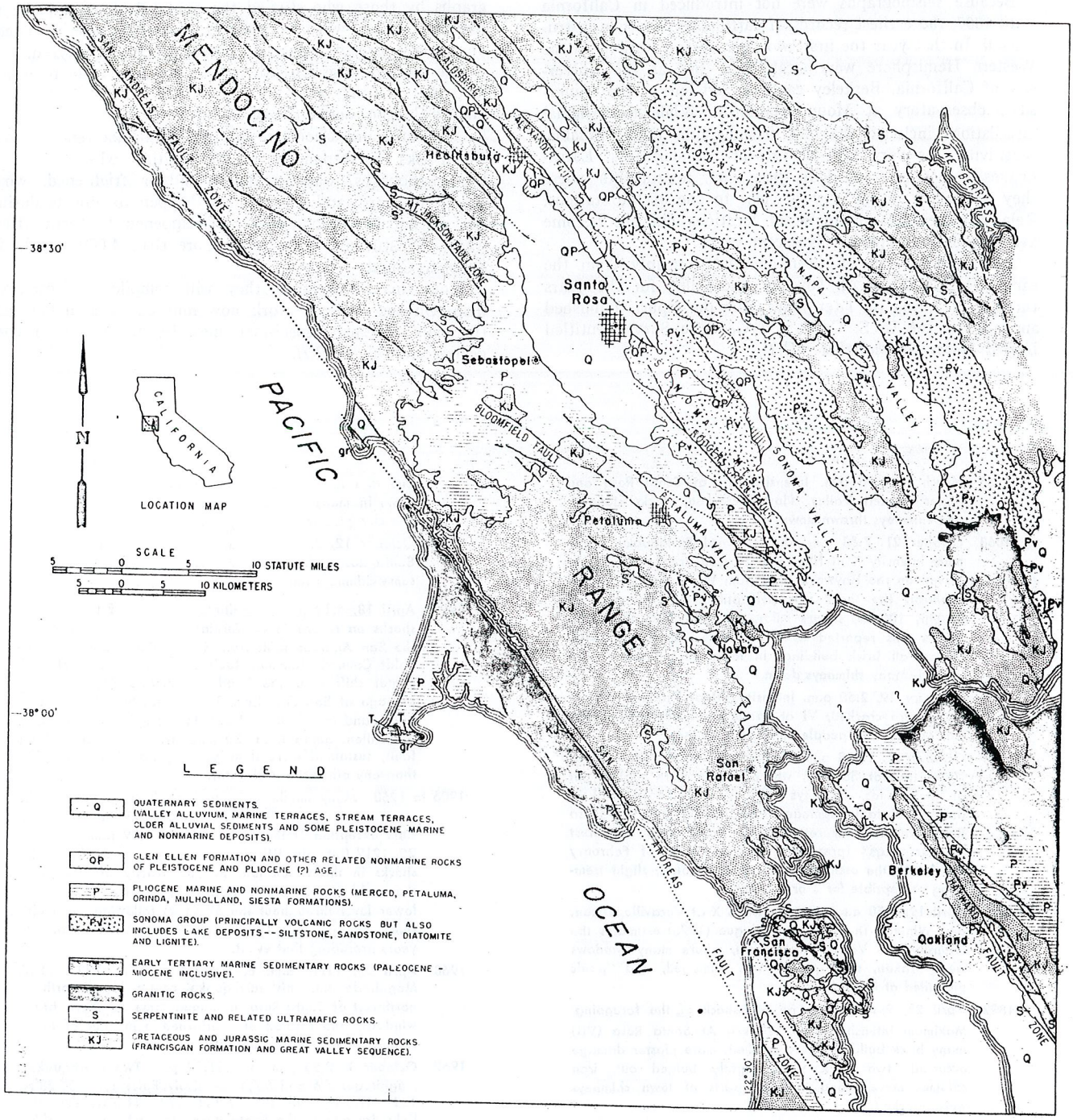
Continued

Month Day Year	Hour Minute Second	Latitude	Longitude	Quality	Magnitude	Number of stations recording	Felt	Maximum intensity, comments
6/12/1936	6–20– 0.	38.40	122.75	D			F	Santa Rosa.
2/28/1939	1–10– 0.	38.40	122.75	D			F	Santa Rosa.
3/ 2/1939	20–13– 0.	38.65	122.90	D			F	Near Geyserville. Felt Cloverdale and Skaggs Springs.
6/ 7/1939	15–14– 0.	38.58	122.83	D			F	Healdsburg-Jenner area. Felt Healdsburg.
10/30/1940	8–35– 0.	38.40	122.75	D			F	Santa Rosa. Possibly an explosion.
7/ 5/1942	0– 0– 0.	38.60	122.85	D			F	Healdsburg. Four shocks. BSSA. Oct. 1942.
10/19/1944	8–37– 0.	38.42	122.75	D			F	Santa Rosa. This and the three following shocks may not have been earthquakes.
10/19/1944	9– 7– 0.	38.42	122.75	D			F	Santa Rosa. See above.
10/19/1944	10– 0– 0.	38.42	122.75	D			F	Santa Rosa. See above.
10/19/1944	13– 0– 0.	38.42	122.75	D			F	Santa Rosa. See above.
11/21/1945	22–56–10.	38.42	122.78	B	3.5		F	III at Santa Rosa.
1/ 2/1948	8–35– 0.	38.50	122.85	D			F	Fulton. Light shock.
2/21/1948	4–19– 0.	38.40	122.75	D			F	IV at Santa Rosa.
9/ 1/1948	21–27–47.	38.33	122.58	B	3.3		F	Felt in Santa Rosa and Cotati.
8/ 9/1949	0–39–27.	38.58	122.67	B	3.6			West of Calistoga.
8/14/1949	8–19–58.	38.58	122.67	D	2.5			Aftershock of quake on August 9 at 0039.
11/ 3/1949	5– 0– 0.	38.40	122.75	D			F	IV at Santa Rosa.
11/ 4/1949	14–45– 0.	38.40	122.75	D			F	Santa Rosa.
11/ 4/1949	14–50– 0.	38.40	122.75	D			F	Santa Rosa.
11/ 8/1949	12–41–16.	38.50	122.70	D	2.5			North of Santa Rosa.
12/28/1950	0–15– 1.	38.58	122.83	C	2.9		F	Felt at Windsor.
2/20/1951	6–52–47.	38.42	122.65	C	2.2			East of Santa Rosa.
4/ 7/1951	19–19–21.	38.30	122.70	D	2.6			North of Petaluma.
11/26/1951	7–21–53.	38.52	122.75	B	3.4		F	North of Santa Rosa. Felt in Santa Rosa.
11/26/1951	8–53–30.	38.53	122.77	B	3.2		F	Aftershock of 0721. Felt in Santa Rosa.
11/26/1951	13–21–26.	38.52	122.75	C	2.1		F	Aftershock of 0721. Felt in Santa Rosa.
7/ 9/1952	22– 4–48.	38.53	122.62	C	2.5			4 miles SE of Calistoga.
9/26/1952	4–35–43.	38.42	122.58	C	3.2		F	7 miles SE of Santa Rosa. IV at Santa Rosa, St. Helena and Kenwood.
11/21/1952	23–27–25.	38.40	122.67	B	2.4			4 miles SE of Santa Rosa.
8/21/1953	10–28– 0.	38.30	122.60	D	2.1			SE of Santa Rosa.
1/29/1954	7–36–56.	38.50	122.65	C	2.8			Northeast of Santa Rosa.
2/25/1955	0–50– 5.	38.40	122.60	C	2.8			East of Santa Rosa.
12/22/1955	8– 4–50.	38.33	122.63	B	3.1			Southeast of Santa Rosa.
5/ 3/1956	3–30–30.	38.43	122.53	C	3.0			East of Santa Rosa.
6/19/1956	18–32–57.	38.28	122.52	B	2.3			Southeast of Santa Rosa.
7/18/1956	23– 3– 7.	38.65	122.73	A	3.5		F	North of Santa Rosa. Felt at Santa Rosa, Windsor.
3/14/1958	6–30–35.	38.60	122.80	D	2.5			Northwest of Santa Rosa. Aftershock, magnitude 2, at 06–32–48.
6/22/1958	6–21– 2.	38.65	122.73	C	3.2		F	North of Santa Rosa. Felt sharply at Healdsburg. Also felt at Rio Nido.
10/29/1959	23–29– 2.	38.40	122.50	D	2.9			Southeast of Santa Rosa.
12/26/1959	0–18–51.	38.40	122.50	D	2.3			East of Santa Rosa.
8/ 5/1960	6–15–53.	38.40	122.60	D	2.0			East of Santa Rosa.
2/28/1962	13–40–32.6	38.57	122.73	B	3.1	14	F	North of Santa Rosa. IV.
3/ 9/1962	8–39– 2.	38.33	122.62	C	3.0	12		Northeast of Point Reyes.
4/14/1962	19–37–37.	38.35	122.60	B	3.0	12		South of Calistoga.
12/ 6/1962	1–41– 6.1	38.52	122.58	B	2.6	11		South of Calistoga.
12/ 7/1963	12– 4–11.6	38.50	122.70		2.7	9		North of Santa Rosa.
9/23/1964	16–30–12.9	38.58	122.72		3.0	7		SW of Calistoga.
7/15/1965	2–57– 8.	38.50	122.80		2.8	8		SW of Rumsey.
10/18/1965	23–19– 0.	38.60	122.70		3.0	9		SW of Rumsey.
10/25/1965	4–50–30.1	38.48	122.88		2.6	9	F	NW of Santa Rosa. Felt at Healdsburg.
6/19/1966	16– 5–31.4	38.32	122.67		2.8	8		South of Santa Rosa.
6/27/1966	6– 4–28.7	38.48	122.83		3.1	9	F	NE of Santa Rosa. V Santa Rosa.
6/11/1967	12–55–48.	38.33	122.67		2.6	9		SE of Santa Rosa.
8/ 2/1967	0–10–35.0	38.50	122.76		2.8	6		NW of Santa Rosa.

Number of quakes = 168.



Map of Santa Rosa area showing epicenters of earthquakes of magnitudes greater than 2.5.



Generalized geologic map of part of the San Francisco Bay area. (Modified after Geologic Map of California, Olaf P. Jenkins Edition, Santa Rosa and San Francisco Sheets.)

HISTORY OF THE STRONGER EARTHQUAKES AT SANTA ROSA, 1865–1969

Because seismographs were not introduced in California until 1887, the earliest records of earthquakes are non-instrumental. In that year the first two seismograph stations in the Western Hemisphere were established—one at the University of California, Berkeley campus, and one at the university's observatory at Mount Hamilton. While the original installations included the best seismographs then available, sensitivity was very low by present-day standards. Earthquakes were not recorded on these early instruments unless they were very strong or very close to one of the stations. Relatively accurate instrumental locations did not become available until comparatively recent years.

The following list has been abstracted mainly from the earthquake catalogue of Townley and Allen for the years through 1927, and for later years from the reports published annually by the U. S. Coast and Geodetic Survey entitled *United States Earthquakes*.—*D.T.*

CONTINUING RESEARCH

Much of the information provided in the previous paragraphs by those who studied the Santa Rosa earthquake is preliminary, and will be revised as new information is added, or material already gathered is more carefully analyzed.

One piece of research still to be completed is an intensity map that is being prepared by students of the Santa Rosa Junior College, under the direction of L. J. Gex. Using the U. S. Coast and Geodetic Survey earthquake report form, which asks the respondent for his location, whether he felt the earthquakes, was awakened, and/or frightened, what noises he heard, and what he saw happen to objects during the earthquake or observed had happened to them afterward, the students interviewed more than 4,000 people in Sonoma County.

From this information, they will compile an isoseismal map. On the basis of work now finished, it is likely that the map will show isoseismal lines describing arcs of concentric circles.—*M.R.H.*

1865 March 8, 6:00 a.m. Intensity VIII at Santa Rosa and upper Bennett Valley. Plaster cracked, clocks stopped, and chimneys thrown down.

1868 October 21, 7:53 a.m. The Hayward Earthquake. Maximum intensity X at Hayward. Surface breakage was observed on the Hayward fault from Warm Springs to San Leandro. The shock was perceptible over an area of roughly 100,000 square miles. At Santa Rosa, the earthquake was reported as the "severest shock yet felt." Nearly all brick buildings in town were more or less injured. Many chimneys down.

1888 February 29, 2:50 p.m. Intensity VII at Petaluma, where walls were cracked; VI at Santa Rosa, where the shock was violent and people ran out of houses.

1891 October 11, 10:28 p.m. Maximum intensity VIII to IX at Napa and at Sonoma, where people were shaken out of their beds, chimneys demolished, windows broken, and considerable damage to plaster occurred. At Santa Rosa, one observer reported the shock as the "severest in four years" (presumably a recollection of February 29, 1888); the oscillations lasted 45 seconds; slight trembling perceptible for 3 or 4 minutes.

1892 April 19, 2:50 a.m. Intensity IX to X at Vacaville, Dixon, and Winters. The Holden catalogue (1893) estimates the intensity was VII at Santa Rosa, where many windows were broken, some plaster was damaged, and "panic prevailed at hotels."

1892 April 21, 9:43 a.m. Large aftershock of the foregoing. Maximum intensity IX at Winters. At Santa Rosa (VII) many brick buildings were cracked, more plaster damage occurred, two brick walls slightly bulged out, iron columns moved, and in some parts of town chimneys were wrecked.

1893 August 9, 1:15 a.m. Sonoma County, VII to VIII at Santa Rosa, where this was said to have been the most severe shock since 1868. Chimneys fell and windows were broken. The plaster in the courthouse was extensively damaged.

1898 March 30, 11:43 p.m. The Mare Island Earthquake (intensity VIII). At Santa Rosa, the vibrations lasted fully one and three-quarters minutes. [illegible] dows in many [illegible] the city plaster [illegible]

1899 October 12, [illegible] Santa Rosa, [illegible] some chimneys fell.

1906 April 18, 5:12 a.m. Magnitude [illegible]. One of the greatest shocks on record in California; [illegible] movement on the San Andreas fault from San [illegible] County to Humboldt County. Maximum fault offset was a 21-foot horizontal shift near the head of Tomales Bay. Extensive damage at San Francisco, Santa Rosa, San Jose, Sebastopol, and many other places. In the opinion of Townley and Allen, Santa Rosa, 20 miles from the San Andreas fault, sustained more damage, in proportion to its size, than any other city in the state.

1906 to 1968 Many smaller earthquakes felt in Santa Rosa, the strongest being in 1919, 1929, and 1955. With the possible exception of the earthquake at 2:39 p.m. February 25, 1919 (intensity VI), none was as severe as the earlier shocks in this tabulation. Seismic activity of interest to the residents of Santa Rosa was clearly at a much lower level throughout the 62 years following the major shock of April 18, 1906, than it had been in the 41 years preceding that event.

1968 April 25, 11:49 a.m. Epicenter 38° 25'N, 122° 40'W. Magnitude 4.5. This earthquake, centered just north or northwest of Santa Rosa, damaged some chimneys, broke windows, and rotated or overturned a number of tombstones. Maximum intensity VIII, at Santa Rosa.

1969 October 1, 9:55 p.m. and 11:20 p.m. Two earthquakes, magnitudes 5.6 and 5.7, respectively. Epicenters 38° 28'N, 122° 41.5'W, and 38° 27.3'N, 122° 41.5'W. Extensive light damage in the Santa Rosa area, where some chimneys fell, many windows were broken, and a half-dozen frame houses were rocked off or overturned their foundations. Partial collapse of several brick building walls occurred, and minor structural damage was noted in one reinforced concrete building. Some minor ground cracking occurred on the northeast edge of Santa Rosa.

—*D.T.*

APPENDIX B

SOIL PROFILES

BLUCHER (BhB)

Ap1, 0 to 9 inches: Dark gray loam, very dark brown when moist; strong, coarse, angular, blocky structure; very hard, friable, nonsticky and slightly plastic texture; many very fine roots; many very fine, interstitial pores; medium acid (Ph 6.0); abrupt, wavy boundary.

Ap11, 9 to 20 inches: Dark gray silt loam with common fine, distinct yellowish-brown mottles; very dark brown when moist with common fine, distinct dark brown mottles; massive; very hard, firm, plastic and nonsticky texture; a few fine and very fine roots, many medium roots; many very fine tubular pores and common fine tubular pores; neutral (Ph 7.0); gradual, smooth boundary.

C1, 20 to 34 inches: Gray fine sandy loam with common fine, distinct yellowish-brown mottles; very dark gray when moist with common fine, distinct dark brown mottles; massive; hard, friable, nonsticky and nonplastic texture; a few fine and very fine roots and common medium roots; many fine and very fine tubular pores; moderately alkaline (Ph 8.0); clear, smooth boundary.

IIA11b, 34 to 45 inches: Dark gray heavy silty clay loam with a few fine, distinct dark yellowish-brown mottles; black when moist with a few fine, distinct very dark grayish-brown mottles; massive; very hard, firm, sticky and plastic texture; a few fine and very fine roots and common medium roots; many very fine tubular pores and common fine tubular pores; moderately alkaline (Ph 8.0); gradual, smooth boundary.

IIa12b, 45 to 57 inches: Dark gray silty clay loam with common fine, prominent dark yellowish-brown mottles; very dark brown when moist with common fine, distinct mottles; slightly sticky and plastic texture; a few fine and very fine roots; a few very fine tubular pores and common fine tubular pores; mildly alkaline (Ph 7.8); gradual, smooth boundary.

IIc2, 57 to 78 inches: Gray heavy silt loam with common medium, distinct dark yellowish-brown mottles; massive; hard, friable, nonsticky and slightly plastic texture; a few very fine roots; common fine and very fine tubular pores; mildly alkaline (Ph 7.5); saturated below a depth of 72 inches.

GOLDRIDGE (GdC and GdD)

Ap, 0 to 7 inches: Light brownish-gray fine sandy loam; yellowish-brown when moist; moderate, very fine granular structure; soft, very friable, nonsticky and nonplastic texture; many fine and very fine roots; common fine and very fine tubular and interstitial pores; very strongly acid (Ph 5.0); clear, wavy boundary.

A1, 7 to 20 inches: Light brownish-gray fine sandy loam; dark yellowish-brown when moist; massive; soft, friable, nonsticky and nonplastic texture; many fine and very fine roots, a few medium and coarse roots; many fine and very fine interstitial and tubular pores; strongly acid (Ph 5.2); clear, wavy boundary.

A3, 20 to 24 inches: Light brownish-gray fine sandy loam; yellowish-brown when moist; massive; slightly hard, friable, nonsticky and nonplastic texture; common fine and very fine roots; many fine and very fine tubular and interstitial pores; a few thin clay films in pores; strongly acid (Ph 5.1); clear, wavy boundary.

B1t, 24 to 28 inches: Light gray fine sandy loam; yellowish-brown when moist; massive; slightly hard, firm, slightly sticky and slightly plastic texture; many fine and very fine roots; many fine and very fine interstitial and tubular pores; many thin clay films in pores; very strongly acid (Ph 5.0); clear, wavy boundary.

B21t, 28 to 41 inches: Pale yellow sandy clay loam with common fine, distinct olive yellow mottles; yellowish-brown when moist with common fine, distinct brown mottles; massive; very hard, firm, sticky and plastic texture; common fine roots and a few medium roots; many fine and very fine tubular pores; continuous thick clay films in pores; very strongly acid (Ph 4.6); gradual, irregular boundary.

B22t, 41 to 57 inches: Mottled, very pale brown and light yellowish-brown sandy clay loam; olive yellow when moist with common light gray streaks; massive; very hard, firm, slightly sticky and slightly plastic texture; a few fine roots; common fine and very fine tubular pores; continuous thick clay films in pores; very strongly acid (Ph 4.5); diffuse, wavy boundary.

Cg, 57 to 72 inches: Very pale brown sandy clay loam with common fine, distinct brownish-yellow mottles; yellow when moist with common large gray mottles; massive; slightly hard, firm, nonsticky and slightly plastic texture; common fine and very fine tubular pores; continuous thick clay films in pores; very strongly acid (Ph 4.5); diffuse, wavy boundary.

PAJARO (PaA)

Ap, 0 to 4 inches: Grayish-brown fine sandy loam; very dark grayish-brown when moist; massive; hard, friable, nonsticky and slightly plastic texture; many very fine roots; many very fine pores; medium acid (Ph 6.0); clear, smooth boundary.

C, 4 to 35 inches: Gray fine sandy loam with common large, distinct yellowish-brown mottles; dark gray when moist with many large, distinct dark yellowish-brown and grayish-brown mottles; massive; hard, friable, nonsticky and nonplastic texture; common very fine roots; many very fine pores; slightly acid (Ph 6.2); abrupt, smooth boundary.

IIa1b, 35 to 54 inches: Gray fine sandy loam with common fine, distinct yellowish-brown mottles; dark gray when moist with common fine, distinct brown mottles; massive; hard, friable, nonsticky and nonplastic texture; a few very fine roots; a few very fine pores; neutral (6.8); diffuse, smooth boundary.

IIa2b, 54 to 72 inches: Grayish-brown fine sandy loam; dark grayish-brown when moist with common fine, distinct yellowish-browm mottles; massive; hard, friable, nonsticky and nonplastic texture; slightly acid (Ph 6.2); abrupt, smooth boundary.

APPENDIX C

SOIL TEXTURES

BLUCHER (BhB)

The surface is gray and grayish-brown in color and is somewhat more stratified with thin layers of fine sandy loam. The finer textures occur from 4 to 8 inches near the surface.

GOLDRIDGE (GdC)

The surface is light brownish-gray to light yellowish-brown to yellowish-brown in color and fine sandy loam to loamy sand in texture. Structure is moderately granular or the soil is massive.

GOLDRIDGE (GdD)

Same as GdC above.

PAJARO (PaA)

Surface layer is gray to grayish-brown in color and has dark brown or dark yellowish-brown mottling* in places. This horizon is massive or has subangular blocky to coarse prismatic structure. It is slightly acid to moderately alkaline.

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*Mottling in soils usually indicates poor aeration and lack of drainage.

APPENDIX D-1

COMBINED SPECIES LIST FOR THE RUSH, WET MEADOW AND GRASSLAND COMMUNITIES

Those species indicated by an asterisk (*) were not actually observed but have a high probability of existing on the site area. These are derived from the Countywide Handbook, Madrone Associates, 1976 (unpublished).

GRASSES

Barley	*Hordeum vulgare*
Blue grass	*Poa annua*
Dogtail	*Cynosurus echinatus*
Farmer's foxtail	*Hordeum leporinum*
Foxtail	*Hordeum spp.*
Orchid grass	*Dactylis glomerata*
Quaking grass	*Briza minor*
Ripgut	*Bromus ridigus*
Ryegrass	*Lolium spp.*
Soft chess	*Bromus mollis*
Soft chess	*Bromus rubens*
Wild oats	*Avena fatua*

FERNS, RUSHES AND SEDGES

Bracken fern	*Pteridum aquilinum*
Pacific rush	*Juncus effusus*
Rush	*Juncus spp.*
Rush	*Luzula spp.*
Sedge	*Carex spp.*
Sedge	*Cyperus spp.*

HERBS

Baby blue eyes	*Nemophilia menziesii*
Blue eye grass	*Sisyrinchium bellum*
Brodiaea	*Brodiaea spp.*
Buttercups	*Ranunculus muricata*
Buttercups	*Ranunculus californica*
Cardamine	*Cardamine oligosperma*
California poppy	*Eschscholtzia californica*
Clover - bur	*Medicago polymorpha*
Clover - yellow sweet	*Melilotus indicus*
Clover - four-leaf	*Trifolium spp.*
Chickweed - field	*Cerastium arvense*
Chickweed - common	*Stellaria media*
Cocklebur	*Xanthium spinosum*
Doc	*Rumex spp.*
Fiddleneck	*Amsinkia spp.*
Filaree - red-stemmed	*Erodium cicutarium*
Filaree	*Erodium botryus*
Geranium	*Geranium dissectum*
Geranium	*Geranium molle*

Golden-eyed grass	*Sisyrichium californicum*
Hairy cat's ears	*Hypochoeris radicata*
Lupine - sky	*Lupinus nanus*
Lupine	*Lupinus bicolor*
Meadow foam	*Limnanthes douglasii var. nivea*
Morning glory	*Convolvulus spp.*
Mugwort	
Mustard - field	*Brassica campestris*
Mustard - black	*Brassica nigra*
Owl's clover	*Orthocarpus annenuatus*
Pineapple weed	*Matricaria matricariodes*
Poison hemlock	*Conium maculatum*
Popcorn flower	*Plagiobothryus nothofulvus*
Red maids	*Calandrinia ciliata var. menziesii*
Shepherd's needle	*Scandex pectin-veneris*
Shepherd's purse	*Capsella burs-pastors*
Sheep sorrel	*Rumex acetosella*
Spergularia	*Spergularia rubra*
Spurry	*Spergula spp.*
*Tarweeds	*Hemizonia spp.*
*Tarweeds	*Madia spp.*
Thistle - bull	*Cirsium vulgare*
Thistle - cow	*Sonchus spp.*
Thistle - Italian	*Carduus pychocephalus*
Thistle - yellow star	*Centaurea spp.*
Thistle	*Cirsium spp.*
Trefoil	*Lotus spp.*
Vetch - giant	*Vicia gigantea*
Vetch	*Vicia spp.*
Vetch	*Lathyrus spp.*
Wild radish	*Raphanus sativus*

WOODY INVADERS

Coyote brush	*Baccharis pilularis var. consanguinea*
Hawthorn	*Crataegus douglasii*
Scotch broom	*Cytisus scoparius*

BIRDS

American goldfinch
*Barn owl
Brewer's blackbird
Common snipe
Crow
House finch
Kestrel
Killdeer
Lesser goldfinch
Loggerhead shrike
Meadowlark
Morning dove
Mockingbird
Red-shouldered hawk
Red-tailed hawk

Red-winged blackbird
Robin

*REPTILES AND AMPHIBIANS

Common kingsnake
Copher snake
Southern alligator lizard
Western fence lizard
Western toad
Treefrog

*MAMMALS

Badger
Beechy ground squirrel
Black-tailed hare
Botta pocket gopher
Broad-handed mole
California meadow mouse
Coyote
Deer mouse
Striped skunk
Vagrant shrew

APPENDIX D-2

COMBINED SPECIES LIST FOR THE OAK SAVANNA, LIVE OAK WOODLAND AND NORTHERN OAK WOODLAND COMMUNITIES

Those species indicated by an asterisk (*) were not actually observed but have a high probability of existing on the site area. These are derived from the Countywide Handbook, Madrone Associates, 1967 (unpublished).

GRASSES

Many of the grasses and other herbaceous species found in the oak woodland communities are listed in Appendix D-1.

FERNS, RUSHES AND SEDGES

Bracken fern	*Pteridum aquilinum*
Gold-back fern	*Pityrogramma triangularis*
Lady fern	*Anthyrium filix-femina*
Polypoidy	*Polypodium californicum*
Wood fern	*Dryopteris arguta*
Wood rush	*Luzula spp.*
Rush	*Juncus spp.*
Sedge	*Carex spp.*

DOMINANT HERBS

Bedstraw	*Galium aparine*
Bedstraw	*Galium nuttallii*
Bermuda Buttercups	*Oxalis pes-capre*
Chickweed	*Stellaria media*
Chickweed - field	*Cerastium arvense*
Clover	*Trifolium spp.*
Doc	*Rumex spp.*
Douglas iris	*Iris douglasiana*
Hidge nettle	*Stachys spp.*
Horsetails	*Equisetum spp.*
Italian thistle	*Carduus pycocephalus*
Miner's lettuce	*Montia perfoliata*
Sheep sorrel	*Rumex acetosella*
Thistle	*Cirsium spp.*
Vetch	*Vicia spp.*

SHRUBS

Blackberry - native	*Rubus vitifolius*
Blackberry - Himalayan	*Rubus procerus*
Coffeeberry	*Rhamnus californica*
Coyote brush	*Baccharis pilularis var. consanguinea*
Currant	*Ribes spp.*
Hawthorn	*Crataegus douglasii*
Honeysuckle	*Lonicera spp.*
Manzanita	*Arctostaphylos manzanita*
Snowberry	*Symphoricarpos spp.*

Wax myrtle	*Myrica Californica*
Western azalea	*Rhododendron occidentale*
Wood rose	*Rosa gymnocarpa*

TREES

Douglas fir	*Pseudotsuga menziesii*
Madrone	*Arbutus menziesii*
Oak - black	*Quercus kelloggii*
Oak - coast live	*Quercus agrifolia*
Oak - Oregon	*Quercus garryana*
Oak - valley	*Quercus lobata*
Oregon ash	*Fraxinum oregano*
Redwood	*Sequoia sempervirens*
Willow - Arroyo	*Salix lasiolepis*
Willow	*Salix spp.*

BIRDS

Acorn woodpecker
Allen's hummingbird
American robin
Anna's hummingbird
*Brown creeper
Brown towhee
Chestnut-backed chickadee
Bushtit
Cedar waxwing
Common flicker
Cooper's hawk
Dark-eyed junco
Downy woodpecker
Golden-crowned sparrow
*Great horned owl
Grosbeak - black-headed
*Hutton's vireo
Northern oriole
Nuttail woodpecker
Plain titmouse
Rufous-sided towhee
Scrub jay
Song sparrow
Thrush - varied
Western flycatcher
White-breasted nuthatch
White-crowned sparrow
Wilson's warbler
Yellow-rumped warbler

*REPTILES AND AMPHIBIANS

Arboreal salamander
California slender salamander
Common kingsnake
Ensatina
Gopher snake

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TREES

Californ
Coast li
Oregon a
Oregon o
Valley o
Willow -
Willow -
Willow

SHRUBS

Blackber
Blackber
Poison o
Snowberr
Western

DOMINANT

Doc
Duckweed
Horsetai
Manroot
Miner's
Mint
Poison h
Rush
Saxifrag
Sedge
Sedge
Stinging
Tule
Water cr
Wormseed
Water He

BIRDS

American
Belted k
Blackpho
*Brown pe
*Common l
*Common m

Northern alligator lizard
Tree frog
Western ring-necked snake
Western skink
Western toad

*MAMMALS

Badger
Beechy ground squirrel
Black-tailed deer
Black-tailed hare
Bobcat
Botta pocket gopher
Broad-handed mole
California meadow mouse
Coyote
Deer mouse
Dusky-footed woodrat
Gray fox
Long-tailed weasel
Raccoon
Spotted skunk
Striped skunk
Vagrant shrew
Western gray squirrel

Common snipe
*Dipper
*Great blue heron
*Green heron
Killdeer
Mallard
*Osprey
Rough-winged swallow
*Ruddy duck
Song sparrow
*Western grebe
*Western wood peewee
Wilson's warbler
*Winter wren
*Wood duck
Yellow warbler

*REPTILES AND AMPHIBIANS

Pacific giant salamander
Rough-skinned newt
California newt
Red-bellied newt
Western toad
Pacific treefrog
Foothill yellow-legged frog
Pacific pond turtle
Common garter snake
Aquatic garter snake
Terrestrial gartersnake

*MAMMALS

Mountain beaver
Western harvest mouse
Deer mouse
Muskrat
Gray fox
Coyote
Raccoon
Mink
Striped skunk
River otter

*MACROSCOPIC INVERTEBRATES

Order Decapoda - Crayfish
Order Megaloptera - Dobsonflies
Order Ephemeroptera - Mayflies
Order Odonata - Dragonflies and damselflies
Order Hemiptera - True bugs
    Family Nepidae - Water scorpions
    Family Belostomatidae - Giant water bugs
    Family Corixidae - Water boatmen
    Family Gerridae - Water striders
    Family Gelastocoridae - Toad bugs

Family Saldidae - Shore bugs
Family Naucoridae - Creeping water bugs
Order Coleoptera - Beetles
Family Gyrinidae - Whirligig beetles
Family Haliplidae - Crawling water beetles
Family Dytiscidae - Predaceous diving beetles
Family Hydrophilidae - Water scavenger beetles
Family Psephenidae - Water pennies
Order Diptera - Flies
Family Blepharoceratidae - Net-veined flies
Family Simuliidae - Blackflies
Family Dixidae - Dixa midges
Family Tenepedidae - Nonbiting midges
Family Tipulidae - Crane flies
Order Trichoptera - Caddis flies

Class Gastropoda - Snails and limpets

APPENDIX D-4

SPECIES LIST FOR THE VERNAL POOL LOCALES

Those species indicated by an asterisk (*) were not actually observed but have a high probability of existing on the site area. These are derived from the Countywide Handbook, Madrone Associates, 1976 (unpublished).

HERBS

Aquatic buttercup	*Ranunculus lobbii*
*Bee thistle	*Eryngium aristulatum*
*Boisduvalia	*Boisduvalia densiflora*
Brodiaea	*Brodiaea spp.*
*Canchalagua	*Centaurium floribundum*
Clover	*Trifolium spp.*
*Cudweeds	*Gnappalium*
*Flowering quillwort	*Lilea scilloides*
*Loosestrife	*Thythrum hysopifolia*
Marsh popcorn flowers	*Plagiobothrys spp.*
Meadow foam	*Limnanthes douglasii var. nivea*
Monkey flowers	*Mimulus guttatus*
Morning glory	*Convolvulus spp.*
*Navarretia	*Navarretia spp.*
Owl's clover	*Orthocarpus spp.*
Pennyroyal	*Mentha pulegium*
*Pogogyne	*Pogogyne douglassii*
Psilocarphus	*Psilocarphus brevissiumus*
Rush	*Juncus spp.*
*Sonoma shunshine	*Blenosperma bakeri*
Vernal pool goldfields	*Tastenia spp.*
*Wild lobelia	*Downingia*

*GRASSES

Annual bentgrass	*Deschampsia danthonioides*
Bentgrass	*Agrostis microphylla*
Pacific foxtail	*Alopecurus howellii*
Semaphore grass	*Pleuropogon californicus*
Velvet grass	*Holcus lanatus*

BIRDS

*Cinnamon teal
Mallard

*MAMMALS

Raccoon
Western harvest mouse

REPTILES AND AMPHIBIANS

*Western toad
Pacific treefrog

*Red-legged frog
*Tiger salamander
*Aquatic gartersnake
*Common gartersnake

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